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CONVERSATIONS

ON

MINERALOGY.

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WITH PLATES,  
*ENGRAVED BY MR. AND MISS LOWRY,*  
FROM ORIGINAL DRAWINGS.

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IN TWO VOLUMES.  
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# CONVERSATIONS ON MINERALOGY.

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## CONVERSATION X.

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MRS. L.

I EXPECT that you will be much delighted this morning, Frances, for you will see scarcely any mineral which does not crystallize. The first species is corundum, which is of three kinds: the transparent varieties are called sapphire; the crystallized and massive ones, which are not transparent, corundum; and the granular corundum is emery.

FRANCES.

So that you have a complete transition from these beautiful transparent crystals to a dirty brown sand.

MRS. L.

Yes; but the emery you have generally seen is not in its natural state; it is ground and washed. You know, I believe, that, next to diamond, sapphire is the hardest substance in nature: it is nearly pure alumina.

MARY.

A short time ago I should hardly have believed any one who might have told me so; but it is not more wonderful than that the diamond should be nearly the same substance as charcoal. What is the primitive form of sapphire?

MRS. L.

A slightly acute rhomboid (fig. 130), which very seldom occurs: but it may be obtained by cleavage; at least from corundum. There is a peculiarity attending the cleavage of corundum which is worth remarking; namely, that in two directions it may be cleaved easily, but in the third with much more difficulty.

FRANCES.

But is not the case similar to that of felspar?

MRS. L.

Not quite. As the three planes of the rhomb forming the summit are similarly situated with respect to the crystal, it is difficult to understand the cause. The most common form is a hexagonal prism, or double acute hexagonal pyramid,

which often exhibits parts of the primitive planes, or faces produced by other modifications. (figs. 132, 133, 134.) You will find some of these little red sapphires nearer to the primitive than any of the other crystals. (fig. 131.)

FRANCES.

They are very perfect indeed ; but—

MRS. L.

But what, my dear ?

FRANCES.

I was going to make a foolish observation about the colour ; I remember now, you said that sapphire was of almost every colour.

MRS. L.

Yes ; the red sapphires are called Oriental rubies, and are easily distinguished from the spinel rubies by their hardness, and their specific gravity, which varies from 3.9 to 4.2, that of spinel not exceeding 3.8. Green is the most uncommon of its colours ; but all sapphires of a pure colour are very much valued, on account of their hardness and brilliancy. The crystals of corundum are similar to some of the sapphire crystals ; but they are generally of a brownish or grey colour, and are opaque, or nearly so.

MARY.

These are very large crystals ; do you know where they were found ?

MRS. L.

Yes; near Madras, imbedded in granite; the corundum from the Carnatic is generally of a light greenish-grey, imbedded in indianite; and it occurs sometimes blue and red; but these colours are seldom bright, though the red always inclines to crimson.

FRANCES.

Here is a specimen, Mrs. L., of a delicate pink and blue; is it corundum?

MRS. L.

Yes; that is a variety from Piedmont, which was discovered but a short time ago. When corundum is burnt it can be reduced to so fine a powder, that in India, where it is rather plentiful, it is rubbed upon razor-strops, or used instead of emery.

FRANCES.

Which is native emery, Mrs. L.? I mean emery in its natural state.

MRS. L.

There are two kinds: this dark-brown variety is the most common; it has a sandy appearance; but the other is very compact, with an uneven or splintery fracture, and is sometimes called diamond spar: the granular emery contains a good deal of the oxyde of iron.

MARY.

I do not admire either of them. Pray what is this very pale green crystal?



MRS. L.

It is chrysoberyl, another precious stone.

FRANCES.

It is much paler and yellower than chrysolite, and some of these fragments are opalescent.

MARY.

Yes ; there is a bluish floating light, like that in moonstone.

MRS. L.

The primitive form is a parallelopiped nearly similar to that of chrysolite, and the secondary crystals are not very different (figs. 135, 136) ; it is scarcely inferior to sapphire in hardness, and the specific gravity is generally 3.6.

FRANCES.

I suppose if I could not take the specific gravity of it, the conchoidal fracture would distinguish it from sapphire, which always seems to break in the direction of the cleavage?

MRS. L.

That is a sensible idea, Frances ; but chrysoberyl *has* cleavages in two directions, though they are difficult to be obtained ; and sapphire is not so easily cleaved as corundum.—The spinel ruby, except a variety of a blue colour, had been always found in detached crystallized grains, till, very lately, small pink spinels were discovered in Ceylon by Dr. J. Davy, imbedded in white marble.

MARY.

And are not the blue spinels in grains?

MRS. L.

No; they are often grouped together: here are some as large as peas, very well crystallized, and imbedded in a similar kind of marble; they are found in Sweden; and the loose crystals, in the sand of Ceylon, along with sapphires, chrysoberyls, and other substances, in round and crystallized grains.

FRANCES.

These are a dull purplish blue: I suppose they are never cut and polished like the red spinels?

MRS. L.

No; they would not be sufficiently transparent, even if the colour were good. But the Indian spinel is not always red; it is sometimes nearly colourless, and often yellowish and greenish white, or pale purple; but mostly transparent. This and the next two substances, ceylonite and automolite, crystallize in the form of the regular octahedron, which is their primitive, and in other forms derived from it. (figs. 137, 138, 141.) The small dark green crystals on this specimen are ceylonite; but they are not very easily seen, being so much intermixed with mica and other minerals.

MARY.

But they are very brilliant, and almost black.

MRS. L.

The crystals of ceylonite are in general *very* small:

those of automolite are larger, and are dull deep blue.

FRANCES.

These substances are both very different from spinel, though they have the same form.

MRS. L.

They are both softer than spinel. The principal difference between them is, that spinel derives its beautiful red colour from the oxyde of chrome; and automolite contains from 24 to 28 per cent of the oxyde of zinc; the rest is chiefly alumina.

MARY.

I think you said that chrome also occasioned the brilliant green of the emerald?

MRS. L.

Yes; the same metals (most of them at least) produce different colours, not only when combined with acids or other substances, but when united with different proportions of oxygen. Dr. Brewster has found that rubies, when heated to a high degree, become green: in cooling, they appear brown, and by degrees resume their red colour, the brilliancy remaining unchanged.

FRANCES.

The specific gravity of the automolite, I suppose, is greater than of the other two species?

MRS. L.

Yes; it is as high as 4.2, and 4.6: that of spinel varies from 3.5 to 3.8. Ceylonite is about 3.7 or

3.80. Andalusite, the last species, has no external resemblance to the others of the ruby family; but I have placed it here on account of its great hardness, and because it consists principally of alumina.

MARY.

Is it as hard as spinel?

MRS. L.

Perhaps they are about equally hard; but the hardness of andalusite is rather variable: some specimens are softer than others. The crystals are rectangular prisms.

FRANCES.

These are very large and perfect; but you cannot see the colour of them, they are so completely covered by scales of—mica, I believe.

MRS. L.

Yes: it always occurs with mica, though not always enveloped in it:—it is generally light grey, and sometimes of a flesh-red, inclining to lilac; with very little lustre, and an indistinct appearance of cleavage parallel to the lateral planes of the prism. Andalusite and all the other substances of this family are infusible before the blowpipe. The next specimen is nepheline—it has been called infusible felspar.

MARY.

There are several substances here; which is nepheline?

|  | * Sapph.<br>phire. | † Corundum.<br>* | † Eme-<br>ry. | † Chryso-<br>beryl. | † Spinel. | § Auto-<br>molite. | Ceylon-<br>ite. | † And-<br>alusite. |
|--|--------------------|------------------|---------------|---------------------|-----------|--------------------|-----------------|--------------------|
| Alumina . . .  | 90.                | 84.              | 53.83         | 71.5                | 74.50     | 60.                | 68.             | 52.                |
| Silica . . . . .   | 7.                 | 6.5              | 12.66         | 18.                 | 15.50     | 4.75               | 2.              | 32.                |
| Lime . . . . .   | —                  | —                | 1.66          | 6.                  | 0.75      | —                  | —               | —                  |
| Magnesia . . .   | —                  | —                | —             | —                   | 8.25      | —                  | 12.             | —                  |
| Oxyde of iron  | 1.2                | 7.5              | 24.66         | 1.5                 | 1.50      | 9.25               | 16.             | 2.                 |
| Do. chrome .   | —                  | —                | —             | —                   | —         | —                  | —               | —                  |
| Do. zinc . . .   | —                  | —                | —             | —                   | —         | 24.25              | —               | —                  |
| Potash . . . . .   | —                  | —                | —             | —                   | —         | —                  | —               | 8.                 |
| Water . . . . .  | —                  | —                | —             | —                   | —         | —                  | —               | 6.                 |
| Loss . . . . .   | 1.8                | 2.               | 7.19          | 3.                  | —         | 1.75               | 2.              | —                  |
| * Chenevix. † Klaproth. † Vauquelin. § Collet-Descotils.    Ekeberg. |                    |                  |               |                     |           |                    |                 |                    |

MRS. L.

The transparent colourless crystals; they frequently occur with meionite, on Vesuvian specimens:—you may easily distinguish them by their crystallization. The nepheline has the form of hexagonal prisms, and sometimes they are very low, so as to appear tabular. This family contains another mineral called bucholzite\*, which I have not seen.

FRANCES.

What is the composition of nepheline?

MRS. L.

It consists of nearly equal parts of silica and alumina. Bucholzite is a pure silicate of alumina; that is, the silica is chemically combined with the alumina, as an acid might be: indeed, silica is considered, in many cases, to act the part of an acid; and such compounds are called silicates. In the next family are three substances, topaz, pyrophyssalite, and pycnite: they differ a good deal in appearance, but very little in composition.

MARY.

I should not have supposed that: this is very much like white felspar.

MRS. L.

That is pyrophyssalite; it is rather harder than felspar, and the specific gravity is about 3.4:—

\* From Bucholz, a celebrated chemist.



besides, when it is exposed to the action of the blowpipe it bubbles a great deal, but is infusible; so that you may easily distinguish them. It is found only at Fahlun in Sweden. But you have not looked at the topazes—here is great variety of crystallization.

FRANCES.

So I perceive; but what is the primitive form, for I like to begin with that?

MRS. L.

The primitive form of topaz is not yet satisfactorily ascertained. It has been supposed to be a rectangular octahedron (fig. 142), or a right rhombic prism (fig. 143): the secondary crystals may be derived from either; but they yield readily to cleavage only in one direction, which is parallel to the bases of the prism. You see that in most of these fragments, two opposite parts present perfectly flat and shining surfaces.

MARY.

And in every other part the fracture is small conchoidal.

MRS. L.

The cleavages parallel to the lateral planes of the prism \* are generally very indistinct; and those on the angles, which are parallel to the planes of the rectangular octahedron, equally so

\* The incidences of these planes are about  $124^{\circ} 22'$  and  $55^{\circ} 38'$  — *Phillips*.

FRANCES.

Are topazes usually crystallized?

MRS. L.

Yes; they are sometimes very much rounded, particularly those from New South Wales and Brazil; but they always have a perfectly crystalline structure. In Siberia, the crystals occur in groups, with quartz crystals. In Saxony, topazes are an essential part of a rock called topaz-rock: it consists of quartz, topazes both massive and crystallized, and schorl, which is disseminated through it in small particles; the Saxon crystals have in general a single terminal plane (fig. 146) perpendicular to the axis.

MARY.

But there is only one end to that.

MRS. L.

Topazes with two terminations are rare: when the two ends are crystallized, they are generally dissimilar, and such crystals are electric when heated. The Siberian topazes are generally terminated by two large planes, forming an edge, and four or more smaller ones. (figs. 145, 147.) These little ones are from Saint Michael's Mount in Cornwall, and those crystals from Brazil. (fig. 144.)

FRANCES.

They seem to be found in many places.

MRS. L.

Yes; topaz is the most widely distributed of the



precious stones. It has been met with in Scotland; and very fine ones are brought from various parts of the East. Its specific gravity is scarcely less than that of spinel, but it is not so hard. It is useful to know this, because some red topazes, when cut, resemble spinel so much that it is very difficult to distinguish them.

MARY.

These rose-coloured ones, for instance;—where are they found?

MRS. L.

They are Brazilian; but that is not their natural colour. It is produced by exposing the deep yellow topazes to a considerable degree of heat for some hours. Topazes, however, sometimes occur of a fine deep-red colour; but they have a slight tinge of brown. Pycnite does not occur in perfect crystals, but consists of thin prismatic concretions, which are sometimes hexagonal; and it has a cleavage across the prisms, but not perpendicular to their axes.

FRANCES.

I think I should have taken it for zoisite, or some kind of schorl, from its structure.

MRS. L.

It has been improperly called schorlaceous beryl, from its structure. The only colours of pycnite are pale lilac, and light straw and sulphur yellow; it is translucent on the edges, and about as hard as pyrophyssalite. These three minerals contain

fluoric acid; but the proportion of it to the other components is so variable, that it is not considered as an essential constituent; and they are not usually included in the class of acidiferous minerals.

MARY.

Those blue specimens, I suppose, belong to the cyanite\* family, which I believe is the next.

MRS. L.

Yes; but it contains other substances besides cyanite and blue spar. Cyanite I think is a beautiful mineral: the blue colour is so brilliant; and it has a pearly lustre, particularly one variety, which appears quite opalescent, and has been named sapparite. I should tell you that cyanite is also called sappare; and by Haüy, disthène, from the circumstance that some of the crystals acquire positive, and some negative electricity, by friction. It is lamellar only in one direction—parallel to two of the lateral planes.

FRANCES.

The crystals are very bright, and some of them nearly transparent. The white silvery talc shows them to great advantage.

MARY.

There is also a radiated specimen;—and what is this, Mrs. L., it is very like cyanite, except that the colour is reddish white?

\* Pronounced kyanite.

MRS. L.

All those radiated specimens are called rhætizite: here is one of a grey colour intermingled with black; the black colour is said to be caused by an intermixture of plumbago.

FRANCES.

What is plumbago?

MRS. L.

It is the substance commonly called black lead. Rhætizite is sometimes light-red. In the British Museum there is a small crystal of cyanite, about three quarters of an inch in length, inclosed in a piece of transparent quartz. It is generally imbedded in talc or mica slate.

MARY.

Is this compact mineral cyanite?

MRS. L.

No; that is bluespar. The blue is lighter, and it has not the purple tinge of cyanite; it is only translucent on the edges, and the fracture is splintery: the specific gravity is 3. Bluespar has been discovered only in the valley of Murz in Stiria. Fibrolite is still more scarce; it was first observed by Count de Bournon, imbedded in indianite.

FRANCES.

It is called fibrolite, I suppose, from its structure. It is extremely similar to some of the radiated zeolites.

MRS. L.

Yes; but this is harder than quartz, and infusible before the blowpipe. The next species is grenatite or staurolite: you have already seen some crystals of it.

MARY.

I do not remember them.

MRS. L.

They occur in the talc slate, with the crystals of cyanite.

FRANCES.

I recollect I was going to ask you what those reddish-brown prisms were, when Mary inquired about the rhætizite.

MRS. L.

The twin crystals of this mineral are remarkably pretty; they sometimes intersect each other at right angles (fig. 153), and sometimes obliquely. (fig. 154.)

MARY.

Those are very curious; but the edges are not so sharp as in the little single crystals. (fig. 152.)

MRS. L.

The next is the zircon family: it includes zircon, hyacinth, and eudyalite, which would be arranged with the garnets, if it did not contain 10 per cent of zirconia.

FRANCES.

Does it crystallize in the same form as garnet?

|                         | *<br>Topaz. | †<br>Pyro-<br>physalite. | †<br>Pycnite. | †<br>Cyanite. | §<br>Blue-<br>spar. | <br>Fibro-<br>lite. | *<br>Grena-<br>tite. |
|-------------------------|-------------|--------------------------|---------------|---------------|---------------------|---------------------|----------------------|
| Alumina . . . . .       | 48.         | 57.74                    | 51.           | 55.           | 71.                 | 58.25               | 47.                  |
| Silica . . . . .        | 30.         | 34.36                    | 38.43         | 30.           | 14.                 | 38.00               | 30.6                 |
| Lime . . . . .          | —           | —                        | —             | 2.            | 3.                  | —                   | 3.                   |
| Magnesia . . . . .      | —           | —                        | —             | 2.            | 5.                  | —                   | —                    |
| Potash . . . . .        | —           | —                        | —             | —             | 0.25                | —                   | —                    |
| Fluoric acid . . . . .  | 18.         | 7.77                     | 8.84          | —             | —                   | —                   | —                    |
| Oxyde of iron . . . . . | 2.          | —                        | —             | 6.            | 0.75                | —                   | 15.3                 |
| Water . . . . .         | —           | —                        | —             | —             | 5.                  | —                   | —                    |
| Loss . . . . .          | 2.          | 0.13                     | 1.73          | 5.            | 1.                  | 3.75                | 4.1                  |

\* Vauquelin.

† Berzelius.

‡ Saussure.

§ Klapproth.

|| Chenevix.

MRS. L.

Yes, generally in the form of the dodecahedron; sometimes with the edges truncated. Part of this specimen is crystallized; it is imbedded in sodalite.

MARY.

It is more of a lilac colour than any garnets which I have seen.

MRS. L.

Yes, that is the chief difference in their appearance. The specific gravity is 2.9. I am surprised that it is not heavier; for zirconia is the heaviest of all the earths: the specific gravity of zircon and hyacinth varies from 4.5 to 4.7. There is, in reality, no difference between these two substances; their composition and primitive form are the same. (fig. 156.) Those crystals which are red, or reddish-brown, are called hyacinth, and they are in general similar to these. (figs. 158, 160.) These crystals (figs. 157, 159) are called zircon, or zirconite.

FRANCES.

It is curious that the crystallization should vary with the colour;—are the zircons of any other colour besides brown?

MRS. L.

Yes; in Ceylon, where both species occur, they are greenish or bluish grey, yellowish white, and sometimes colourless. The red hyacinths are found in France also, and the zircons in Norway. Here



is a crystal in zircon-syenite, nearly an inch long, and a quarter of an inch in diameter ; it is one of the largest I have ever seen.

FRANCES.

Is it never found massive, in the manner of quartz or hornblende ?

MRS. L.

No ; it appears to be always in detached crystals.

MARY.

These grey ones are not at all pretty ; are they ever cut ?

MRS. L.

Yes, very frequently. They are employed in watch jewellery, and are often substituted for diamonds, which they resemble in having a very oily lustre, even when polished ; but they are not so hard as spinel ruby, and are rather brittle.

FRANCES.

The lustre is very peculiar ; I think I could distinguish them even without taking the specific gravity.

|             | Silica. | Zirconia. | Lime.        | Soda.   | Oxyde of iron. | Oxyde of manganese. | Muriatic Acid. | Water or volatile matter. | Loss. |
|-------------|---------|-----------|--------------|---------|----------------|---------------------|----------------|---------------------------|-------|
| * Zircon .  | 33.     | 65.       | - -          | - -     | 1.             | - -                 | - -            | - -                       | 1.    |
| † Hyacinth  | 31.     | 66.       | - -          | - -     | 2.             | - -                 | - -            | - -                       | 1.    |
| ‡ Eudyalite | 52.4783 | 10.8968   | 10.1407      | 13.9248 | 6.8563         | 2.5747              | 1.0343         | 1.8010                    | -     |
| * Klaproth. |         |           | † Vauquelin. |         |                | ‡ Stromeyer.        |                |                           |       |

MRS. L.

I need not tell you the name of these crystals.

MARY.

No ; I shall always know emeralds when I see them, their colour is so peculiar.

FRANCES.

I remember you said that the green of the emerald was produced by chrome ; but it is far more beautiful than the colour of smaragdite.

MRS. L.

I believe, if smaragdite were as transparent as these emeralds, you would not find much difference between them. Emerald and beryl appear to be exactly the same substance, except that the colouring matter of the beryl is iron. Their primitive form is a hexagonal prism ; but it is very frequently modified. (figs. 161, 162, 163, 164.)

MARY.

Is this yellow crystal a beryl ?

MRS. L.

Yes ; that colour is not common : they are usually of a bluish or sea-green colour, for which reason they have been called aqua-marine, which is still their most common name.

FRANCES.

How could I distinguish a yellow beryl from topaz, if they were both cut ?



MRS. L.

By its specific gravity, which does not exceed 2.78; that of topaz is above 3.; and beryl is not quite so hard as topaz.

MARY.

Will you be so good as to show me how this crystal is derived from the primitive? I cannot understand it. (fig. 165.)

MRS. L.

That is not a beryl, my dear, but a crystal of euclase; its primitive form is an oblique rhombic prism. I believe the primitive crystal has not been yet found in anatural state; but Dr. Wollaston has determined, from its cleavage, that the angles made by the lateral planes are  $115^{\circ} 10'$  and  $64^{\circ} 50'$ . I am not surprised at your thinking it a beryl; its colour and the channels on the lateral planes give it a considerable resemblance. The first crystals of euclase that were brought to England were sold as green topazes; but it differs both from topaz and beryl in its crystallization and softness, and is characterized by great frangibility. It has several cleavages, but the one most easily obtained is in the direction of the shorter diagonals of the prism.

MARY.

What is the chief difference between the composition of euclase and of beryl, or emerald?

MRS. L.

Euclase contains less silica, and a greater pro-

portion of glucina and alumina, than the other two ; which may perhaps account for its being less hard.

## FRANCES.

Are none of these minerals found in England ?

## MRS. L.

No ; euclase is found in Peru and Brazil, but very sparingly, and in isolated crystals. Emeralds are at present brought only from Peru ; but it is conjectured that the ancients, who valued them very much, procured them from Ethiopia. Mr. Belzoni discovered some emerald mines there, but was not fortunate enough to find any good specimens. They are rarely found imbedded in quartz and micaceous slate. An impure variety, of a greenish yellow colour, and nearly opaque, has been discovered at Limoges. Beryls are far more abundant and more widely distributed ; they are frequently imbedded in granite, or occur in groups, connected by iron ochre : they have been discovered at Cairngorm in Scotland, and in the county of Wicklow in Ireland\*, and very large. A large

\*

|             | Alumina. | Silica.      | Glucina. | Lime.        | Oxyde of iron. | Oxyde of chrome. | Oxyde of tin. | Water. | Loss. |
|-------------|----------|--------------|----------|--------------|----------------|------------------|---------------|--------|-------|
| * Emerald   | 16.      | 64.5         | 13.      | 1.6          | —              | 3.25             | —             | 2.     | —     |
| † Beryl . . | 15.      | 68.          | 14.      | 2.           | 1.             | —                | —             | —      | —     |
| ‡ Euclase . | 30.56    | 43.32        | 21.78    | —            | 2.22           | —                | 0.70          | —      | 1.42  |
| * Klaproth. |          | † Vauquelin. |          | ‡ Berzelius. |                |                  |               |        |       |

quantity of well crystallized beryls was obtained from the Morne mountains in the county of Down. They were found in small cavities, together with detached crystals of dark-brown transparent quartz.

MARY.

I had no idea that so many precious stones were to be found in this part of the world. Are they as valuable as the Oriental stones?

MRS. L.

Prejudice has attributed a fictitious value to many Eastern productions, both natural and artificial, independently of their intrinsic merit; but in regard to precious stones the case is different: the Oriental ruby, topaz, and amethyst, are all sapphires; and these, from whatever country, would always be more prized than the gems from which they are named, on account of their greater hardness and brilliancy.

This other specimen does not belong to the emerald family, which is the last of the earthy minerals; but it is a singular substance, and has not been analysed.

FRANCES.

It seems to consist of very small white crystals, disseminated through slate.

MRS. L.

Those crystals are chiastolite, or hollow spar: if

you examine them, you will find that they are really hollow, and filled by the same kind of slate as that in which they are imbedded. (fig. 166.)

MARY.

That is very curious: is it always the case?

MRS. L.

Yes; but in this larger crystal the black substance within it extends to the corners of the prism. (fig. 167.)

FRANCES.

It is a beautiful crystal: it seems to contain five black prisms. I am delighted with this, because it is not like any thing else.

MRS. L.

I have some other minerals, which, from not being analysed, have not yet been arranged in any system,—such as humite, thulite, and melilite: but they are very unimportant, and I have not all of them; so that I think we had better proceed immediately to the acidiferous earthy class, beginning with those substances which consist of *lime* united to an acid.

MARY.

It is found combined with several acids; is it not?

MRS. L.

Yes; the carbonate of lime is the most abundant of its combinations, and perhaps the most abundant of all simple minerals. There is scarcely any

country in which carbonate of lime may not be found, either in the form of limestone, chalk, marble, or calcspar. The family of carbonates may be divided into three parts: the first eight species are nearly pure carbonates; the others are magnesian and argillaceous. But I think we had better defer the examination of this genus till tomorrow, as it is very extensive.

## CONVERSATION XI.

MRS. L.

YOU will have little to examine in the calcareous spar, except its crystallization, which is more various than that of other substances. Comte de Bournon, in his elaborate treatise on this mineral, has enumerated fifty-six modifications; which, differently combined, furnished him with above six hundred varieties of form.

FRANCES.

What an astonishing number !

MARY.

It is difficult to imagine how so many planes can be situated.

MRS. L.

All the modifications do not however occur on the same crystal; seldom more than five or six are seen together. Some of the most simple forms you have already seen; the primitive rhomb (fig. 168), the equiaxe (fig. 170), the hexagonal prism, the metastatic dodecahedron, and the dog's-tooth crystal. It is rather remarkable, that most of the fine calcspar of Derbyshire is of a deep topaz-yel-



low colour, like these large crystals; and that found in Leicestershire is quite colourless, and the crystals are generally small.

FRANCES.

Here are some of a beautiful light yellow; but the crystals are not perfect.

MRS. L.

That specimen is an aggregation of acute rhomboids; and you see only one half of them: it is from Alston Moor. (fig. 176.) Bournon mentions fourteen rhomboids of different degrees of acuteness, produced by various decrements. This one (fig. 173) is called the inverse rhomb, because the plane angles are the same as those of the primitive; but the rhomb is acute.

MARY.

That is a curious circumstance;—but what are these crystals, Mrs. L.; not carbonate of lime, surely?

MRS. L.

It is called Fontainebleau sandstone; but it is in reality carbonate of lime, which has entangled a great quantity of fine white sand. The crystals are inverse rhombs, which do not appear to differ from those of the pure carbonate of lime, except that their surface is rough and granular.

FRANCES.

How very strange that is! But I suppose this is

not a chemical combination, or the crystallization would be different.

MRS. L.

Your observation is very correct; the sand and carbonate of lime are only mechanically mixed. I dare say you remember a large transparent rhombic fragment of calcspar in the British Museum, which is placed over a card with "double refraction" written on it.

MARY.

O yes, perfectly; and the letters appeared as if written twice.

FRANCES.

Some one said it was Iceland spar.

MRS. L.

It is often called so, though all carbonate of lime has the same property of showing two images of any thing placed behind it; but probably this was first observed in the large transparent fragments which are found in Iceland. This is a very good specimen.

MARY.

If you turn it round, one of the two lines appears to move, till at last they form but one.

FRANCES.

How do you account for this property?

MRS. L.

I am afraid that I cannot make the theory of it



intelligible to you, because you know nothing about optics, or the refraction of light.

Sometimes the calcspar of Iceland has a beautiful lilac tint: and here is a crystallized specimen from Shropshire, of a pale pink colour.

FRANCES.

These little crystals on it are quartz, I believe?

MRS. L.

Yes: calcspar occurs with a great variety of minerals; very often with fluat of lime, pyrites, sulphuret of lead, and other metallic ores. Have you remarked how distinctly the natural joints are visible in many of these crystals?

MARY.

Yes: in that one particularly, it seems as if the slightest effort would divide it parallel to the primitive rhomb.

MRS. L.

This is a macle, or hemitrope crystal. (fig. 206.)

FRANCES.

Here is a specimen that appears to have another cleavage, perpendicular to the axis of the rhomb.

MRS. L.

That cannot be called a true cleavage, although it is very distinctly indicated by striæ in the direction of the longer diagonals of the faces. It is the effect of an interrupted crystallization; and frequently some foreign substance is interposed be-

tween the laminæ. This variety of calcspar is abundant in Sweden and Norway. Slatespar is a good example of this structure. This is from Norway.

MARY.

I should have thought it foliated, rather than slaty.

MRS. L.

The *apparent* cleavage, in the direction of the folia, is perpendicular to the axis of the rhomb; the *real* cleavage may be seen on the edges of some of the laminæ. It is nearly opaque, and the folia frequently curved. When thrown on hot coals, it phosphoresces with a pale yellow light.

FRANCES.

It appears to be very delicate.

MRS. L.

Yes, it is: but the next specimen is much more so; it will not allow of being handled.

MARY.

How very silvery it is; like talc.

MRS. L.

It is called aphrite, or earth-foam; and the name would apply equally well to the next species,—rock-milk.

FRANCES.

This has a very different appearance: it is quite dull and earthy. I should have taken it for chalk.

MRS. L.

You will find them rather different if you compare them. Rock-milk is very light: some varieties will float on water. It is supposed to be a deposition from the mountain streams which pass over limestone rocks; and in Switzerland, being very abundant, it is used for whitening houses, and for other purposes to which chalk is applied in England.—That is chalk.

MARY.

I never saw any chalk like this; I thought it was always soft, and perfectly white.

MRS. L.

What you have generally seen is *whitening*. Chalk is powdered and diffused through water, and the fine part of the sediment dried: by this process the siliceous particles which it contains are separated; and the remainder, which is whitening, is less compact than chalk in its natural state, which is usually greyish or yellowish.

FRANCES.

Chalk is never crystallized, I suppose?

MRS. L.

If it were crystalline, it would no longer be chalk, but calcspar, or marble.

MARY.

Is not this specimen marble?

MRS. L.

Yes; it is a variety of limestone, which from its

imperfect crystallization, is termed foliated-granular. The Parian marble exhibits this structure very distinctly.

FRANCES.

I see perfectly what you mean. It is composed of large grains, which are all separately foliated; so that the fracture is quite brilliant.

MRS. L.

The Carrara marble consists of much smaller grains, and is less translucent.

MARY.

It is exactly like fine white sugar.

MRS. L.

It sometimes includes small crystals of quartz, which are called Carrara diamonds. Both these varieties, and others which are quarried in Italy, Greece, and the Greek Islands, were employed by the ancients for the purposes of sculpture: the only one which is much used at present, is the marble of Carrara. Some pretty varieties, adapted for ornamental architecture, are quarried in Devonshire: but Spain affords a greater variety of richly-coloured marbles than any other country. These granular limestones rarely contain petrifications: in the compact limestones they are often abundant.

FRANCES.

Which is common limestone, Mrs. L.?

MRS. L.

Those grey and yellowish specimens; they are compact. The colours are generally light and dull;

and the fracture varies from large conchoidal to uneven or earthy, depending on the degree of compactness. Sometimes the colours are brighter. The grey marble of Plymouth, spotted and veined with red and white, is a compact limestone; and the grey marble of Derbyshire. They both abound in fossil remains.

MARY.

Are those white marks in the Derbyshire marble, petrifications?

MRS. L.

Yes: the greater part of them are the stems of *entrochi*; and from their resemblance to screws, are vulgarly called screw-stones. Other marbles contain shells: the most beautiful of these is found at Bleiberg in Carinthia;—it is called *lumachella*, and, from the fine colours which it reflects, fire-marble.

FRANCES.

That is really almost as brilliant as opal.

MARY.

Is this also compact limestone?

MRS. L.

No; it is *öolite*, or roestone, so called from its resemblance to the roe of a fish.

MARY.

It is exactly like it, in colour and every respect.

MRS. L.

You would not suppose, from its appearance,

that it is one of the best building stones in the world. The finest is quarried at Ketton in Northamptonshire, and is very durable.

The fibrous limestone is a mineral which I think you have already seen.

FRANCES.

Is it not called satin-spar.

MRS. L.

Yes, from its silky lustre. It is sometimes made into necklaces and other ornaments. But it is not *all* fibrous limestone that has this appearance; the fibres of some varieties are much coarser.

FRANCES.

What is this, Mrs. L?

MRS. L.

It is called peastone; the other side of the specimen is polished, and you may see that the little globular concretions which compose it, are concentric-lamellar.

MARY.

Yes; they have the same appearance as an onion when it is cut through, except that they are smaller.

MRS. L.

Peastone is found in large masses in the neighbourhood of the hot springs of Carlsbad in Bohemia, which contain calcareous matter. Each of these little spherical masses contains grains of fine sand: these are supposed to be raised by means of



air bubbles in the water, and to collect round them calcareous particles, till they acquire so much weight that they fall down, and are agglutinated together. In some of them you will perceive alternate depositions of sand, and carbonate of lime. This carbonate of lime is like that contained in some of the springs of Derbyshire, which are commonly called petrifying springs.

FRANCES.

I remember seeing a broom and a bird's nest at Matlock, which the people assured us were petrified; but I suppose they were only incrustated.

MRS. L.

Nothing more; if you were to break them, you would find the interior quite unaltered. This incrusting substance is called calc-tuff, or calcareous tufa. Some of these specimens have been formed upon moss.

MARY.

Is it pure carbonate of lime?

MRS. L.

I believe it has not been analysed; but it is most likely that it contains iron, which gives it a grey or yellowish colour; it is generally very brittle. Stalactites also are produced by the deposition of carbonate of lime from water; but the process is slower than in the formation of calc-tuff; so that they are frequently crystalline.



FRANCES.

This specimen is like calcareous spar, except in its external form.

MRS. L.

They are not always pendent from the roofs of caves, but frequently incrust the sides of walls, where the water trickles down; and in this way they are frequently formed in limestone quarries.

MARY.

But, Mrs. L., if the carbonate of lime is once dissolved in water, why should it be separated, or precipitated from it?

MRS. L.

I was going to explain to you, that although insoluble in pure water, it may be held in solution by water containing a superabundance of carbonic acid; and this combination is not unfrequent in nature. The calcareous liquid oozes slowly through the rocks, till it reaches the roof of the cave: there, before a drop is formed sufficiently large to fall by its own weight, some of the carbonic acid escapes by exposure to the air, and particles of calcareous matter adhere to the roof: every successive drop deposits particles in the same manner, till at length a stalactite is formed.

FRANCES.

How very curious! And in this way the particles

have time to arrange themselves with perfect regularity, so as to produce a foliated structure.

MARY.

And some are covered with little crystals.

MRS. L.

Sometimes the percolation of the water is so rapid, that the calcareous particles are not separated till they reach the ground or floor of the cave: in this case the concretions grow upwards, and are called stalagmites. Sometimes both kinds are formed, and the depositions increase till they meet; and thus magnificent pillars arise, which seem to support the roof of the cave. The most celebrated stalactitic cave is in the island of Antiparos, of which I dare say you have read an account.

FRANCES.

Yes; the description leads one to imagine it the most brilliant and beautiful place in the world.

MRS. L.

It is a pity that it has not been examined by any mineralogist; for there is no good account of any part except that called the grotto. Stalactites were called alabaster by the ancients, who valued it very much.

The lucullite, or black limestone, is of two kinds, compact and foliated.

MARY.

The compact variety does not appear to be very black.

MRS. L.

Not in its natural state ; but when polished, the black is very intense. If you rub two pieces together, or scrape one with a knife, you will perceive a much worse smell than that produced by the fat quartz.

FRANCES.

Is it the same sort of smell ?

MRS. L.

Yes ; one variety is so extremely fetid, that it is called stinkstone or swinestone. Try it.

MARY.

It is very disagreeable indeed ; what is that owing to ?

MRS. L.

It is caused by bitumen, which is a constituent of all black limestone. There is a kind found in Dalmatia, which is said to be so bituminous that it may be cut like soap : it is used there as a building stone ; and when the walls of a house are finished, they set fire to them, and the bitumen which is very inflammable, burns away.

FRANCES.

What is the use of that ?

MRS. L.

When the bitumen is destroyed, the stone remains white; and the heat is not great enough to reduce it to the state of quicklime.

MARY.

It is made by burning limestone in a kiln, is it not?

MRS. L.

Yes; that process deprives it of the carbonic acid. Madreporite is another variety of black limestone, named from its resemblance to the structure of madrepores; the *cross-fracture* is small and curved-foliated: the smell of this kind is not so strong as of the stinkstone. The specific gravity of stinkstone is 2.7. The next species differs from calcspar more in composition than in appearance. It is a hydrous carbonate of lime.

FRANCES.

What is that?

MRS. L.

The name signifies that it contains water as an essential constituent, which does not exist in the simple carbonate. The quantity is 11 or 12 per cent.

MARY.

Is there any particular character by which it may be known?

MRS. L.

It is harder than calcspar, and the specific gravity less, about 2.58; and you may observe that

|                         | *<br>Slate-<br>spar. | *<br>Aph-<br>rite. | *<br>Chalk. | †<br>Compact limestone. | †<br>Calc-<br>spar. | *<br>Calc-<br>sinter. | §    | **<br>Lucillite. | ††<br>Arragonite. |
|-------------------------|----------------------|--------------------|-------------|-------------------------|---------------------|-----------------------|------|------------------|-------------------|
| Lime .....              | 55.                  | 51.5               | 56.5        | 53.                     | 48.                 | 55.5                  | 58.  | 53.37            | 94.8249           |
| Carbonic acid .....     | 41.7                 | 39.                | 43.         | 42.5                    | 38.                 | 44.                   | 28.5 | 41.5             | —                 |
| Silica .....            | —                    | 5.7                | —           | 1.12                    | 7.                  | —                     | 1.25 | 1.25             | —                 |
| Alumina .....           | —                    | —                  | —           | 1.                      | 4.                  | —                     | —    | 1.25             | —                 |
| Magnesia .....          | —                    | —                  | —           | —                       | —                   | —                     | 0.50 | —                | —                 |
| Charcoal .....          | —                    | —                  | —           | —                       | —                   | —                     | 0.25 | 1.25             | —                 |
| Oxyde of iron .....     | —                    | 3.3                | —           | 0.75                    | 2.                  | —                     | 0.28 | 1.25             | —                 |
| ----- manganese ..      | 3.                   | —                  | —           | —                       | —                   | —                     | 0.28 | 0.75             | 0.0939            |
| Carbonate of strontian. | —                    | —                  | —           | —                       | —                   | —                     | —    | —                | 4.0836            |
| Potash & mineral acids  | —                    | —                  | —           | —                       | —                   | —                     | —    | 2.13             | —                 |
| Sulphur .....           | —                    | —                  | —           | —                       | —                   | —                     | —    | 0.25             | —                 |
| Water .....             | —                    | 1.                 | 0.5         | 1.63                    | 1.                  | 0.5                   | 11.  | —                | 0.9831            |
| Loss .....              | 0.3                  | —                  | —           | —                       | —                   | —                     | 0.25 | —                | 0.0145            |

\* Bucholz.

† Simon.

† Phillips.

§ Blue Vesuvian limestone—Klaproth.

\*\* John.

†† Stromeyer.

the fracture is not perfectly foliated, but approaches to splintery. It has been called blue Vesuvian limestone, from its pale blue colour and locality; but it has been found also at the Giant's Causeway in the north of Ireland.

FRANCES.

Are not these white shining crystals, calcspar?

MRS. L.

No; they are arragonite, so called from having been first discovered in Arragon. For some time it was called *hard carbonate of lime*, as it is harder than the other species, but their real difference was not known: it has since been found to contain 3 or 4 per cent of the carbonate of strontian, which produces a very material change in its crystallization. Its primitive form is a right rhombic prism (fig. 206): one angle at the base is  $116^{\circ} 5'$ , so that the hexagonal prisms formed by an aggregation of three of them are not regular. Three of the angles are more obtuse than the other three. You will understand this better by looking on the end of one of these crystals. (fig. 207.)

MARY.

That is really very remarkable: but is not this a regular hexagonal prism?

MRS. L.

No; it is formed by the aggregation of several modified rhombic prisms; and in this large one,



which is of the same kind, you may see that the base has a radiated appearance: and you will find that the other faces have a slight re-entering angle parallel to the lateral edges. (fig. 208.) But the prettiest crystals are these formed by the aggregation of four. (figs. 209 and 210.)

FRANCES.

They are very small, but exceedingly perfect.

MRS. L.

Transparent crystals of arragonite are not common; but lately some have been found at Kosel in Bohemia, from two to three inches in length, perfectly transparent and well crystallized. One of the most beautiful varieties has been named *flos ferri*\*.

MARY.

How exceedingly delicate that is.

FRANCES.

It is more like a white coralline than any thing else.

MARY.

It appears to be covered with minute crystals; and some parts are transparent.

MRS. L.

Some of the terminations of the shoots, if I may so call them, are very perfectly crystallized.

\* Flower of iron.



FRANCES.

Where are these found, Mrs. L.?

MRS. L.

Chiefly in the iron-mines of Stiria and Carinthia ; but good specimens of a smaller size are occasionally met with in the lead and coal mines of the north of England : and a white variety, resembling fibrous zéolite, occurs near Torquay in Devonshire. The specific gravity of arragonite is about 2.9.

We now come to the second division of this family ; it comprehends minerals composed of carbonate of lime, and a large portion of carbonate of magnesia.

MARY.

I suppose, then, that the crystals are very unlike those of carbonate of lime?

MRS. L.

No ; it is a curious circumstance, that the angles of the primitive rhomboid of dolomite differ from those of carbonate of lime only in  $1^{\circ} 10'$ . The obtuse edges measure  $106^{\circ} 15''$ .

FRANCES.

Without a goniometer, the crystallization would not assist me in distinguishing it from carbonate of lime.

MRS. L.

No ; but the effect of the acids is the most simple method by which you can discover whether the

carbonate of lime contains magnesia. Dolomite effervesces very feebly—pure carbonate of lime very briskly. Here are some very large and nearly transparent crystals from Traversella in Piedmont.

MARY.

These are much larger than any of your primitive crystals of calcspar.

MRS. L.

In general the primitive rhombs of calcspar are small.

FRANCES.

This one is modified.

MRS. L.

It is, I think, a remarkable circumstance, that dolomite should present so little diversity of crystalline form. The only two modifications I have observed tend to produce acute rhomboids.

There are other varieties of it. One, called common or massive dolomite, bears a considerable resemblance to the Carrara marble, but is of a looser texture, so that it is easily crumbled. It generally occurs with ores of metals. Compact dolomite or magnesian limestone is the most abundant. These specimens are from Nottinghamshire and Leicestershire.

MARY.

It is very like the common limestone: is it used for the same purposes?

MRS. L.

Yes ; and the lime obtained from it is considered the best for making mortar, because it absorbs carbonic acid from the atmosphere much more slowly than pure lime. Near Sunderland there is a kind of compact dolomite which is flexible. This thin piece is particularly so.

FRANCES.

It appears to me more surprising than the flexible sandstone, because it is so much more compact.

MRS. L.

I forgot to tell you that the foliated dolomite is sometimes called bitter spar, because the soluble salts of magnesia have a bitter taste ; and a greenish variety is called miemite, from Miemo in Tuscany, where it was discovered. The next species is named guruhofian or guruhofite, from Gurhof in Austria, the only place where it is found.

MARY.

How very compact it is.

FRANCES.

I have seen something like it, but I cannot remember what it is.

MRS. L.

It is like semi-opal ; but this is always white, and only translucent on the edges. Pearlspar is the most common of these species : it is not a very plentiful mineral, but is met with in a great variety

of situations. In most of these specimens you will see lead ore, copper pyrites, quartz, and calcareous spar.

MARY.

How strangely the crystals appear to be twisted. (fig. 211.)

MRS. L.

Yes ; that distortion is characteristic of pearlspar.

FRANCES.

I suppose it would be difficult to measure the angles of them accurately ?

MRS. L.

The result could not be depended upon ; but it is probable that the angles are the same as those of dolomite. It is generally either yellowish-white, or brown, with a strong pearly lustre.

MARY.

It seems to have incrustated these large crystals completely.

MRS. L.

Yes ; they are cubes of fluor. The pearlspar appears bright, because you see the edges of a multitude of small crystals ; it is harder than calc-spar, but may be scratched by dolomite. Fibrous pearlspar is a less common variety ; it appears like divergent tufts of delicate acicular crystals, or else forming small botryoidal masses, which, when broken, exhibit a fibrous structure. The specific gravity of pearlspar is 2.88 : upon the whole, these

minerals are distinguished from the simple carbonates of lime by their greater hardness and specific gravity, and their very weak effervescence with acids\*.

FRANCES.

And what is this earthy substance, Mrs. L.?

MRS. L.

It is earthy marl. It is very variable in its appearance, being a mixture, partly chemical and partly mechanical, of carbonate of lime, alumina, and sand or silica.

MARY.

It is something like loam, but feels softer.

MRS. L.

The indurated marl has a very different aspect: it is compact, like some of the common clays.

FRANCES.

Will it effervesce with acid?

|                      | *<br>Common | *<br>Foliated<br>Dolomite. | †<br>Compact | *<br>Gurhof-<br>ite. | ‡<br>Pearl-<br>spar. |
|----------------------|-------------|----------------------------|--------------|----------------------|----------------------|
| Carbonate of lime .  | 52.         | 68.                        | 56.8         | 70.                  | 49.19                |
| — of magnesia        | 48.         | 25.5                       | 40.84        | 30.                  | 44.39                |
| Oxyde of iron . . .  | 0.2         | 1.                         | 0.36         | —                    | 3.4                  |
| — manganese . . .    | —           | —                          | —            | —                    | 1.5                  |
| Clay, Water, &c. . . | —           | 4.                         | 2.           | —                    | —                    |
| Water . . . . .      | —           | —                          | —            | —                    | 0.13                 |
| Loss . . . . .       | —           | 1.5                        | —            | —                    | 1.39                 |
| * Klaproth.          | † Thomson.  |                            | ‡ Hisinger.  |                      |                      |

MRS. L.

Yes, very readily; a property which at once distinguishes it from clay. It is found in roundish masses, and sometimes a number of small globes are aggregated together. Very often these masses are intersected by numerous fissures, which are partly, and sometimes completely, filled up with calcareous spar. I have one cut and polished.

MARY.

What a beautiful dark brown !

FRANCES.

The white veins of calcareous spar running through it have a very pleasing effect. Is it ever used as marble ?

MRS. L.

Not this kind, which is called *septarium* ; but the Florence and Cottam marbles are varieties of indurated marl. In these, the prevailing colour is a sort of light buff, and the landscapes and ruins which it exhibits appear as if drawn with bistre.

MARY.

I recollect some pieces in the British Museum. One represents arches and broken walls, and figures.

MRS. L.

It is a pity that the figures have been added : it might lead one to suppose that the other delineations were artificial. It is from the brown part of



the septarium that the substance called Parker's cement is manufactured. Another variety, containing bitumen, and having a slaty structure, is called bituminous marl-slate; it is always nearly black, and often includes petrifications of fishes.

The family of phosphates of lime contains but two species, apatite and phosphorite.

FRANCES.

Are they very different from each other?

MRS. L.

In appearance they are, but not in composition: apatite is generally crystallized, and strongly translucent, or transparent; but phosphorite is always amorphous and opake.

MARY.

I should have thought these were crystallized beryls; the form and colour are exactly the same. (fig. 212.)

MRS. L.

They are so. It resembles several minerals so strongly, that before it was analysed it was confounded with them by many mineralogists; and, on this account, Werner gave it the name of apatite, which is derived from the Greek word *απαταω* (apatāo), *to deceive*. Some of it is of a lilac colour, and extremely like fluor, but the fracture is generally conchoidal.



FRANCES.

These little crystals appear to be perfectly colourless and transparent. (fig. 213.)

MRS. L.

There is a magnificent crystal of this form (fig. 215) in the British Museum above an inch in diameter. Some green and bluish varieties are called moroxite, and the pale yellow green, asparagus stone. It is harder than calcspar, but phosphorite is rather soft.

FRANCES.

Would not you call this cellular?

MRS. L.

Yes; it is full of small cavities, and appears as if it had been broken up and cemented by an ochry substance.

MARY.

I never saw any fracture like this.

MRS. L.

It resembles the palmed fracture of the massive albite, but is on a smaller scale: that is the siliceous phosphorite. These minerals are found in Bohemia and in Estremadura.\* An earthy kind of

\*

|               | Lime. | Phosphoric acid. | Carbonic acid. | Muriatic acid. | Fluoric acid. | Silica. | Oxyde of iron. |
|---------------|-------|------------------|----------------|----------------|---------------|---------|----------------|
| * Apatite .   | 55.   | 45.              | —              | —              | —             | —       | —              |
| * Apatite .   | 53.75 | 46.25            | —              | —              | —             | —       | —              |
| † Phosphorite | 59.   | 34.              | 1.             | 0.5            | 2.5           | 0.5     | 1.             |
| * Klaproth.   |       |                  |                | † Pelletier.   |               |         |                |

phosphorite is found in Hungary, of a very loose texture. Both kinds phosphoresce when laid on hot coals. This property seems to be common to many of the combinations of lime. Some of the carbonates and nearly all the fluates possess it. One variety of fluate of lime is called chlorophane, from the brilliant green light which it emits when heated. Here is a piece of it, which I will put in the fire.

FRANCES.

Its appearance is by no means beautiful at present.

MRS. L.

It requires a little time to become sufficiently hot, and must not be too quickly heated: it is generally of a purplish-brown colour; and the cleavage is not so distinct as in the common foliated fluor, or fluor spar.

MARY.

See! it is becoming green rapidly.

FRANCES.

And now it is quite brilliant, like an emerald.

MRS. L.

This experiment may be frequently repeated without injuring the chlorophane, if you do not heat it too much. The crystallizations of fluor are beautiful and various; some of them very complex, particularly in the specimens from the lead-mines of Beeralston. (figs. 222, 223.)

MARY.

I remember seeing a great deal of fluor in Derbyshire : but this is not the kind that is turned into vases and candlesticks, is it ?

MRS. L.

No : you will see some of that kind presently. I wish you to look at these crystals. (fig. 220.)

MARY.

They are cubes, with the edges bevelled.

FRANCES.

Then the cube is the primitive ?

MRS. L.

That appears probable at the first glance ; but the cleavage gives a very different figure. Perhaps you can form an idea of it, from observing some of these crystals which have been fractured.

FRANCES.

I see that the cleavages are not parallel to the planes of a cube.

MRS. L.

No ; they are parallel to the faces of an octahedron. Here is one (fig. 216) ; and this (fig. 218) is a figure intermediate between the octahedron and dodecahedron : but the cube, and some forms which appear easily derived from it, are the most common.

MARY.

It is very strange that in so many substances the

primitive crystal should so seldom occur. Where are these dark-purple crystals found? (fig. 221.)

MRS. L.

In the tin-mines of Cornwall; and large quantities of pale-green fluor occur in some of the copper-mines. It is used as a flux in smelting the copper ores. This is the first use to which fluor was applied\*. It is not often colourless; and light-blue and pink are unusual colours. Rose-coloured octahedrons are found in the mountain St. Gothard. You will not have much difficulty, I think, in distinguishing it from other minerals; its crystallization is generally very perfect, and its cleavages are so easily obtained, that the natural joints are almost always visible when the crystals are transparent or translucent.

FRANCES.

What metal is this with the fluor?

MRS. L.

It is sulphuret of lead. Fluor is very often found in lead-mines. The kind which is used for ornamental purposes has a coarse fibrous or columnar structure, like amethyst, and occurs in large concretions in the limestone rocks of Derbyshire. In its natural state it is of different shades of blue, grey, or topaz-yellow. The rich deep-purple tints

\* Its name is derived, as well as the word flux, from the Latin verb *fluo*, to flow.

of these specimens are produced by heating the blue varieties, which the miners call Blue John.

MARY.

I think it is one of the most beautiful minerals we have seen.

MRS. L.

Observe what a number of different substances occur with it.

FRANCES.

Yes, in this specimen there are crystals of quartz, pearlspar, carbonate of lime, and lead ore.

MRS. L.

And the fluor of Cornwall is accompanied by mica, topazes, apatite, quartz, and oxyde of tin. Compact fluor is by no means common: it is a good deal like some other minerals, particularly compact felspar, but is much softer. Very nearly all the acidiferous minerals may be scratched with a knife.

MARY.

Will any besides the carbonates effervesce with acids?

MRS. L.

No; but fluor possesses a remarkable property, which is peculiar to it.

FRANCES.

What is that?

MRS. L.

The fluoric acid, which is one of its constituents,

is the only one that has the power of acting on glass : like carbonic acid, it is aëriform ; and if it be disengaged by means of another acid (as sulphuric, or nitric), a piece of glass exposed to the gas will presently be corroded.

MARY.

I have heard of etching on glass : is it done by means of fluoric acid ?

MRS. L.

Yes ; a varnish is thinly spread over the glass on which the pattern is drawn that is intended to be corroded : and it is placed over a shallow vessel containing pounded fluor and sulphuric acid. Wherever the varnish remains, the glass is unaltered ; but where it is removed, it has the appearance of ground glass.

FRANCES.

I never thought of it before, but I suppose our staircase windows are patterned in this manner ?

MRS. L.

I rather think not. I believe a cheaper and more certain process is usually adopted for common purposes. There is still another variety of fluor ; it is in a loose earthy state, and generally of a grey or purple colour.

MARY.

The purple appears very dull by the side of the crystallized fluor.

MRS. L.

Sometimes it is so dark as to appear nearly



black.\* Compact and foliated fluor are harder than apatite, and scratch carbonate of lime readily; but the *sulphates* of lime are mostly very soft. There are two kinds of sulphate of lime, or gypsum: the one contains water; the other does not, and is called anhydrous gypsum, or anhydrite:—this kind is harder than carbonate of lime. There are several varieties of both these minerals.

FRANCES.

What are these transparent crystallized specimens?

MRS. L.

They are foliated hydrous gypsum, or selenite: it has but one distinct cleavage; and in that direction it may be split with great ease. I will give you a slice of this large piece.

MARY.

How beautifully transparent and colourless it is!

FRANCES.

And how very like it is to stilbite!

MRS. L.

Yes, it has the same pearly lustre, particularly in some specimens where the folia are curved; but it is not perceptible in these small crystals. (fig. 225.) The primitive is a right prism, and its bases are parallelograms. (fig. 224.) It is said that selenite was much used for windows before the invention of glass.

\* Fluor-spar contains 67.34 of lime, and 32.66 of fluoric acid.—*Thomson*.



MARY.

I should have thought mica would answer better.

MRS. L.

Perhaps it would ; but there are few places where mica of a sufficient size is found : and in France, Spain, and other parts of the south of Europe, selenite is very abundant, and easily obtained. The Romans imported it from the island of Cyprus, Spain, and even Africa, and lighted their green-houses with it. Foliated granular gypsum has the same relation to selenite, that marble has to calc-spar.

FRANCES.

This appears very similar to the Parian marble.

MRS. L.

Yes : but it is so soft, that it is not fit for making statues, except on a very small scale. Vases, and other ornamental articles, are made of it. The Romans are believed to have lighted their temples by means of lamps placed in vases of gypsum, for it is sometimes strongly translucent. \*

MARY.

Are these grey and yellowish pieces of the same kind ?

\*

|                       | Lime.     | Sulphuric acid. | Water. | Loss. |
|-----------------------|-----------|-----------------|--------|-------|
| * Compact Gypsum      | 34.       | 48.             | 18.    | —     |
| † Foliated granular   | 32.       | 30.             | 38.    | —     |
| ‡ Sparry, or Selenite | 33.9      | 43.9            | 21.    | 2.1   |
| * Gerhard.            | † Kirwan. | ‡ Bucholz.      |        |       |

MRS. L.

Yes: and it is very frequently of a brick-red colour, which is occasioned by an intermixture of iron ochre.

FRANCES.

Is not this satin spar, Mrs. L.?

MRS. L.

No, my dear; it is fibrous gypsum: but when cut, or turned, it is often sold for satin spar. The fibres, or rather thin columns, of which it is composed, are in general remarkably straight and parallel; but in satin spar they are frequently waved.

MARY.

Besides, satin spar is harder, and effervesces with acids, which, you said, sulphates of lime would not do.

MRS. L.

And it is heavier: the specific gravity of the gypsum is about 2.2. or 2.3. The earthy gypsum is generally yellowish and very friable; but the compact kind is about as hard as the other subspecies. It is not found in England: but there are many quarries of the granular gypsum in Nottinghamshire and Derbyshire. It is used principally as a manure for particular soils, and to make plaster of Paris.

FRANCES.

How is plaster of Paris prepared?

MRS. L.

The gypsum is burnt, in order to deprive it of the water it contains, and it becomes a white powder. In this state it has a strong affinity for water, so that when they are mixed, they rapidly unite, and form a substance which resembles gypsum in composition, though not in texture.

MARY.

I am much obliged to you for this explanation; I have often made casts of medals and seals with plaster of Paris, and could not imagine what became of the water. I had no idea till lately that it could become solid without being frozen.

MRS. L.

It must doubtless appear singular to persons entirely unacquainted with chemistry; but you have now learnt that *water of crystallization* exists in many minerals.

The varieties of anhydrite are nearly the same as those of gypsum; the foliated kind has been also called *muriacite* by some mineralogists, because it sometimes contains a very minute portion of common salt, which is *muriate of soda*. Its crystallization is very different from that of *selenite*: the primitive is a square prism (fig. 227), which sometimes exhibits several modifications, but they are rather scarce. The cleavage, which is threefold, is in general distinct.

## FRANCES.

This is very transparent and bright.

MRS. L.

It is most commonly of a very pale flesh-red, and sometimes, though rarely, pale yellow, violet, and grey: the other varieties are generally bluish-white, or white. It is considerably heavier than selenite: the specific gravity varies from 2.85 to 3. The siliciferous anhydrite has been found only at Vulpino in Italy, and thence called vulpinite;\* but in Italy it is known by the name of *marmo bardiglio di Bergamo*, and Comte de Bournon has given it the name of bardiglione. The sulphates of lime are very abundant; but the other combinations of lime, the carbonates and fluates excepted, are scarce, and present few varieties. Besides

|  | *<br>Compact<br>Anhydrite. | *<br>Radiated<br>Anhydrite | †<br>Vulpinite. |
|--|----------------------------|----------------------------|-----------------|
| Lime . . . . .                         | 42.                        | 42.                        | } 92.           |
| Sulphuric acid . .                     | 56.50                      | 57.                        |                 |
| Silica . . . . .                       | —                          | 0.5                        | 8.              |
| Muriate of soda .                      | 0.25                       | —                          | —               |
| Oxyde of iron . .                      | —                          | 0.10                       | —               |
| Loss . . . . .                         | 1.28                       | —                          | —               |
| Glauberite ‡.                          |                            |                            |                 |
| Anhydrous sulphate of lime             |                            |                            | 49              |
| Anhydrous sulphate of soda             |                            |                            | 51              |
|  |                            |                            | 100             |
| * Klaproth. † Vauquelin. ‡ Brongniart. |                            |                            |                 |

these minerals, two others are arranged in this family, which contain other constituents as well as sulphate of lime. Glauberite, which is a very scarce substance, is found crystallized in the form of a very oblique prism (fig. 228), somewhat resembling an acute rhomb, and imbedded in rock-salt at Villaruba in New Castille.

MARY.

What is it composed of, besides sulphuric acid and lime?

MRS. L.

It contains 51 per cent of sulphate of soda, which is commonly known by the name of Glauber salt; and the sulphate of lime it contains is anhydrous. Its hardness is rather greater than that of gypsum.

FRANCES.

Is this fibrous mineral another belonging to the family of sulphates?

MRS. L.

Yes; it was formerly described as fibrous anhydrite; but the analyses of Stromeyer having proved that it is a combination of several salts, he has named it polyhallite.\* It is found at Ischel

\* Polyhallite.

|                                    |       |
|------------------------------------|-------|
| Dry sulphate of lime . . . . .     | 22.36 |
| Hydrous sulphate of lime . . . . . | 28.74 |
| Dry sulphate of magnesia . . . . . | 20.11 |
| Sulphate of potash . . . . .       | 27.40 |
| Muriate of soda . . . . .          | 0.19  |
| Oxyde of iron . . . . .            | 0.32  |

in Upper Austria, in the strata of rock-salt; its brick-red colour is no doubt occasioned by oxyde of iron, intermixed, but not chemically combined, with it. Perhaps this is the cause of its translucency not being great.

MARY.

Is it ever crystallized?

MRS. L.

No crystals have yet been discovered, but it is not impossible that they may exist: it is a little harder than carbonate of lime, but is scratched by fluor, and is brittle. Combined with silica and boric acid, lime forms datholite and botryolite;—the principal difference between them seems to be, that the datholite is crystallized, and the botryolite occurs in small botryoidal masses, which have an earthy fracture, or, when rather larger, splintery and imperfectly fibrous.

MARY.

How could I distinguish the datholite from some other minerals that are like it?

MRS. L.

When it is crystallized, you would not find it difficult. There are some good crystals on this specimen. (figs. 229, 230.) It does not effervesce; and you may distinguish it from white felspar, or adularia, by its softness: it may be scratched by a knife, but is harder than the other calcareous minerals. In general, the crystals are rather dull ex-



ternally, and never transparent, but the fracture appears vitreous : the specific gravity is 2.98.

FRANCES.

Is this another specimen of datholite ?

MRS. L.

No ; that is humboldtite, a lately described substance, which appears to have nearly the same composition as datholite : but it has not yet been strictly analysed ; in consequence, I believe, of the small quantity which can be procured of it.

MARY.

The crystals appear to be very complex.

MRS. L.

Yes ; they are much more so than any which I have seen of datholite. The primitive form is a right rhombic prism, more obtuse than that of datholite\*. It has been found near Sonthofen in the Tyrol.

FRANCES.

And what are these small crystals ?

MRS. L.

They are tungstate of lime ; it is a little like datholite, but the specific gravity is 5.5 or 6.

MARY.

I see this is crystallized in octahedrons.

MRS. L.

Yes ; but they are not *regular* octahedrons : this

\* The angles are  $115^{\circ} 38'$  and  $64^{\circ} 22'$ .

one (fig. 233) is the most common, but the primitive is more acute. (fig. 231.) It does not melt when exposed to the action of the blowpipe, but crackles and becomes opaque. Arseniate of lime, also called pharmacolite, occurs in very small globular concretions, which consist of minute acicular crystals, disposed in a radiated manner: they are disseminated over this specimen of granite.

FRANCES.

Is the pink colour of them produced by the arsenic?

MRS. L.

It is owing to arseniate of cobalt, but it is merely the surface that is tinged; internally, the colour is nearly snow-white. Silicate of lime is called tabular or table spar; I believe, because it splits into tabular fragments.

MARY.

I think you said the white shining substance intermixed with the cinnamon stone was table spar?

MRS. L.

Yes; but in general it is of a greenish or greyish colour, and has a crystalline structure, exhibiting indications of a twofold cleavage: it is about as hard as datholite, and translucent.

FRANCES.

Are these garnets which are imbedded in the table spar?

MRS. L.

Yes; they are generally found together in the Bannat of Temeswar. In North America, table spar occurs with colophonite.

MARY.

Are any of the other combinations of lime found in England, besides the carbonates, sulphates, and fluates?

MRS. L.

Yes; the phosphate of lime occurs in Cornwall, in the tin veins of St. Michael's Mount, and at Stenna Gwyn; and in granite at Calderbeck in Cumberland: and tungstate of lime has been found in a tin vein of Pengelly Croft mine in Cornwall. Datholite is at present found only near Arendahl in Norway, and in the Giesalpe in the Tyrol. There is one more native salt of lime—the nitrate, which however occurs only as an efflorescence on old walls, or in the caverns of calcareous rocks.

|                | *<br>Datho-<br>lite. | *<br>Botryo-<br>lite. | * †<br>Tungstate of<br>lime |        | *<br>Arseniate<br>of lime. | *<br>Silicate<br>of lime. |
|----------------|----------------------|-----------------------|-----------------------------|--------|----------------------------|---------------------------|
| Lime . . .     | 35.5                 | 13.5                  | 17.60                       | 9.400  | 25.                        | 45.                       |
| Silica . . .   | 36.5                 | 36.                   | 3.                          | —      | —                          | 50.                       |
| Boracic acid . | 24.                  | 39.5                  | —                           | —      | —                          | —                         |
| Tungstic acid  | —                    | —                     | 77.75                       | 80.417 | —                          | —                         |
| Arsenic acid . | —                    | —                     | —                           | —      | 50.54                      | —                         |
| Water . . .    | 4.                   | 6.5                   | —                           | —      | 24.46                      | 5.                        |
| Oxyde of iron  | Trace                | 1.                    | —                           | —      | —                          | —                         |
| Loss . . .     | —                    | 3.5                   | 1.65                        | 0.183  | —                          | —                         |
| * Klaproth.    |                      |                       | † Berzelius.                |        |                            |                           |

## CONVERSATION XII.

FRANCES.

THE next genus, I believe, contains the acidiferous *aluminous* minerals.

MRS. L.

Yes ; excepting lime, alumina is found combined with a greater number of acids than any of the earths. The first family contains two different combinations of alumina with sulphuric acid ; those containing the smallest proportion of acid are called subsulphates : alum is a sulphate containing also potash. You have seen it in the form of a white efflorescence on alumslate ; it occurs, more rarely, massive with a fibrous structure. Of this kind, very fine specimens have been brought by Dr. Meryon from a cave in Mount Lebanon.

MARY.

I suppose its peculiar taste would assist me to distinguish it from all minerals which it resembles in appearance ?

MRS. L.

Yes ; and it is exceedingly fragile—more so than most substances.

FRANCES.

Here is something like porcelain earth ; is it another kind of alum ?

MRS. L.

No; that is aluminite, a subsulphate of alumina; it is very like porcelain earth, but is so compact that it does not soil the fingers, but feels something like steatite: and if you powder a small quantity, and throw it into a glass of water, you will find that it will not diffuse itself through it like porcelain earth, but will sink immediately to the bottom of the glass. Alumstone is another variety, found principally at Tolfa near Rome, where there is a hill of it: the Roman alum, which is considered the best, is prepared from it.

FRANCES.

It appears to be harder than aluminite.

MRS. L.

Yes, it is considerably harder, and in taste resembles the native alum. For making alum, it is first broken up, and exposed to heat for twelve or fourteen hours in a sort of kiln, which is technically called *roasting* it. This operation is generally repeated, that all the pieces may be equally calcined: it is afterwards placed on a sloping floor, in parallel ridges, between which there are trenches filled with water; and the alumstone is frequently sprinkled, till it cracks and falls to powder. The next operation is boiling it with a sufficient quantity of water, stirring it all the time. At the end of twenty-four hours the fire is extinguished, and the liquor left at rest, for the undissolved part to subside: when this has taken place, the clear liquor

is suffered to run through a wooden spout into square wooden reservoirs, where it crystallizes.

FRANCES.

What is the form of the crystals?

MRS. L.

The regular octahedron, generally with the angles truncated, and sometimes the edges. You might make very pretty specimens for your mantle-piece, by putting pieces of coke, or any other mineral not too compact, into a very strong solution of alum; the crystals will be abundantly deposited on them in groups, and have a very brilliant appearance.

The phosphate of alumina is called wavellite, after Dr. Wavell of Devonshire; it is disseminated over the quartz and slate of these specimens, in little spheres about the size of peas, or rather larger.

MARY.

How very round they are!

FRANCES.

Some of them are broken, and show their radiated structure; I remember your mentioning it as a very good example of that.

MRS. L.

You may see the terminations of the crystals on the exterior of some of these, which produce their crinkled appearance.

MARY.

I can see them; but the crystals are more perfect in these little tufts. (fig. 234.)



MRS. L.

The colour of the surface is generally ochry-brown; but internally the wavellite of Devonshire and Cornwall is greyish white, and in small splinters transparent. The green variety, and the black (which is nearly opaque), are found in Ireland.

FRANCES.

Is it not like the radiated prehnite?

MRS. L.

Yes; there is considerable similarity between them.

MARY.

I am afraid I shall often mistake one for the other.

MRS. L.

Recollect that the fibrous prehnite becomes slightly electric when heated, and that it is harder than wavellite; also, that wavellite is generally attached to a dark-coloured slate, while prehnite occurs with quartz.

FRANCES.

It is a beautiful mineral. What are these deep-blue crystals?

MRS. L.

They are azurite, a substance very rarely crystallized; it generally occurs in small irregular masses, imbedded in quartz. It was arranged with lapis lazuli before its composition was ascertained; but their colour is very different.

MARY.

This is not nearly so beautiful, and it is transparent.

MRS. L.

It is a combination of phosphate of alumina and phosphate of magnesia; and the colour may perhaps be caused by phosphate of iron, which is always blue. Cryolite is a fluuate of alumina: there are two varieties, both from Greenland.

FRANCES.

How beautifully white this one is! Does it ever crystallize?

MRS. L.

I believe not: but it is lamellar, and may be cleaved into right-angled parallelopipeds. Its most distinctive characters are, that it melts, like ice, by simple exposure to the flame of a candle, before it can become red-hot; and that its translucency is increased by immersion in water.

MARY.

Those experiments are easily tried, and are very curious. Is it found in any other country besides Greenland?

MRS. L.

Not hitherto. It is rather remarkable that the white cryolite is never intermixed with any other substance, but the brown variety contains galena, iron pyrites, carbonate of iron, quartz and felspar. The little amber-coloured crystals and fragments

|                                  | * Alumstone. |      | Aluminite.† | Wavellite.§ | Azure stone.§ | Cryolite.† | Mellite.† |
|----------------------------------|--------------|------|-------------|-------------|---------------|------------|-----------|
| Silica . . . . .                 | 24.          | 56.5 | —           | —           | 2.10          | —          | —         |
| Alumina . . . . .                | 43.92        | 19.0 | 29.868      | 37.20       | 35.73         | 23.5       | 16.       |
| Magnesia . . . . .               | —            | —    | —           | —           | 9.34          | —          | —         |
| Soda . . . . .                   | —            | —    | —           | —           | —             | 36.        | —         |
| Potash . . . . .                 | 3.08         | 4.0  | —           | —           | —             | —          | —         |
| Sulphuric acid . . . . .         | 25.          | 16.5 | 23.370      | —           | —             | —          | —         |
| Phosphoric acid . . . . .        | —            | —    | —           | 35.12       | 41.81         | —          | —         |
| Mellitic acid . . . . .          | —            | —    | —           | —           | —             | —          | 46.       |
| Fluoric acid and water . . . . . | —            | —    | —           | —           | —             | 40.5       | —         |
| Oxyde of iron . . . . .          | —            | —    | —           | —           | 2.64          | —          | —         |
| Water . . . . .                  | 4.           | 3.   | 46.762      | 28.         | 6.06          | —          | 38.       |
| Loss . . . . .                   | —            | 1.   | —           | —           | 2.32          | —          | —         |

\* Vauquelin.

† Klaproth.

‡ Stromeyer.

§ Fuchs.

imbedded in this piece of bituminized wood are mellate of alumina, or mellite. (figs. 235, 236.)

FRANCES.

How should I know that they were not amber, if I were to find any?

MRS. L.

Amber never crystallizes, and when it is burnt emits a pleasant smell, and becomes black and shining; but mellite when burnt acquires the colour and texture of chalk. All these minerals, except the alumstone, are very rare.

MARY.

Is not this also aluminite, Mrs. L.?

MRS. L.

No, it is carbonate of magnesia: its effervescence with acids, though slow, is sufficient to distinguish it. This kind is about as hard as calcspar, and is found in small quantity in several parts of the Continent: the variety found in India is in the state of a white powder or small roundish lumps; it contains 28 per cent of carbonate of lime. Meerschaum is a far more plentiful species of carbonate of magnesia. In Turkey it is very abundant, particularly in Natolia, where six or seven hundred men are employed in digging it.

FRANCES.

What use do they make of it? It is so very light, I should not suppose it would be a good building stone.

MRS. L.

No, it is used to make the boles of tobacco-pipes: its lightness arises from its being extremely porous—some of it will float on water.\*

When it is first taken from the ground it is very soft, and froths like soap on being mixed with water; so that it is used for washing linen by the Turkish women, and for cleaning their hair. For making pipes, it is first mixed with water in large reservoirs, and, after being agitated, is left at rest for some time: a kind of fermentation takes place, and a very unpleasant smell is exhaled. As soon as this ceases, it is repeatedly washed in order to purify it, and when partly dried, it is pressed into moulds, which are afterwards hollowed out. The boles, in this state, are first dried in the shade, and afterwards baked in a furnace. The yellow and brownish tints on the surface of them, are communicated by boiling them in oil and wax.

MARY.

In its natural state it appears like rock-cork, except being whiter.

FRANCES.

And what are these yellowish-white crystals? I should have thought them pearlspar, if we had not passed that some time ago.

MRS. L.

They perfectly resemble it in outward appear-

\* Meerschaum signifies sea-foam. The French call it *ecume de mer*.

ance; but they contain no lime: they consist of 86 parts of carbonate of magnesia, and 13 of carbonate of iron.

MARY.

And are the angles of the rhomb exactly the same as those of pearlspar?

MRS. L.

No, there is a slight difference between them; these being  $107^{\circ} 30'$  and  $72^{\circ} 30'$ . These crystals are found in the Tyrol; single, and imbedded in talc and chlorite.

FRANCES.

What is the efflorescence on this specimen, Mrs. L.?

MRS. L.

It is sulphate of magnesia: it is more commonly known by the name of Epsom salt, because it was first discovered in the water at Epsom, which contains it in solution. Massive Epsom salt has been found lately in New South Wales. You know its disagreeable bitter taste, I dare say.

MARY.

O yes; and I remember you told us yesterday that the salts of magnesia were bitter: I did not know that Epsom salt was one of them. Here are some of those curious electrical crystals (figs. 237 and 238) which you showed us once before.

MRS. L.

Yes; they are borate of magnesia, or boracite. I have some almost transparent and colourless; but,



in general, they are nearly opaque, and of a light dirty grey. I have never seen a cube less modified than this. (fig. 236.)

FRANCES.

All these crystals are detached: are they ever imbedded in any thing else?

MRS. L.

Yes, they are found imbedded in gypsum at Luneberg in Hanover, and near Kiel in Holstein; the only two places where it has been found: the specific gravity is about 2.9. It is sufficiently hard to scratch glass, which is a rare circumstance in the saline minerals.\* The minerals of the next genus are characterized by their great specific gravity.

MARY.

This is uncommonly heavy, indeed.

|                       | *<br>Carbon-<br>ate of<br>magnesia. | †<br>Meer-<br>schaum. | ‡<br>Sulphate<br>of<br>Magnesia | §<br>Borate of Mag-<br>nesia. |      |
|-----------------------|-------------------------------------|-----------------------|---------------------------------|-------------------------------|------|
| Magnesia . . . . .    | 48.                                 | 17.25                 | —                               | 13.50                         | 16.6 |
| Silica . . . . .      | —                                   | 50.50                 | —                               | 2.                            | —    |
| Lime . . . . .        | —                                   | 0.50                  | —                               | 11.                           | —    |
| Alumina . . . . .     | —                                   | —                     | —                               | 1.                            | —    |
| Carbonic acid . . .   | 52.                                 | 5.                    | —                               | —                             | —    |
| Boracic acid . . . .  | —                                   | —                     | —                               | 68.                           | 83.4 |
| Water . . . . .       | —                                   | 25.                   | 50.                             | —                             | —    |
| Sulphate of magnesia  | —                                   | —                     | 48.6                            | —                             | —    |
| Sulphate of soda . .  | —                                   | —                     | 1.4                             | —                             | —    |
| Oxide of iron . . . . | —                                   | —                     | —                               | 0.75                          | —    |
| Loss . . . . .        | —                                   | 1.75                  | —                               | 3.75                          | —    |

Bucholz.

§ Westrumb.

† Klaproth.

|| Vauquelin.

‡ Thomson.

FRANCES.

I think you said the specific gravity of barytes was above 4.?

MRS. L.

Yes; this is carbonate of barytes, or witherite: its specific gravity is 4.2 or 4.3. It is not often crystallized.

MARY.

This appears to have the form of quartz. (fig. 240.)

MRS. L.

Yes; some of the crystals have a thin ochry crust, but internally they are nearly colourless, and, in general, strongly translucent; except the outside of the radiated masses, which sometimes exhibit pyramidal terminations. Massive witherite is very plentiful in the lead-mines in the North of England, and is found in several parts of the Continent.\* The finest crystals I have, are from Shropshire and the Arkendale lead-mines in Yorkshire.

FRANCES.

The crystals on this specimen do not seem to have much similarity to the witherite; are they sulphate of barytes?

MRS. L.

No; that is baryto-calcite, a compound of car-

\* Carbonate of barytes.

|               | Barytes. | Carbonic acid. | Water. |
|---------------|----------|----------------|--------|
| Vauquelin . . | 74.5     | 22.5           | —      |
| Bucholz . .   | 79.66    | 20.            | 0 33.  |

bonate of barytes and carbonate of lime. It was brought from Cumberland, as a variety of carbonate of barytes, which it resembles in fracture and in having a high specific gravity: but the crystals being very different, Mr. Brooke examined them, and determined the primitive form to be an oblique rhombic prism; which, however, has not occurred without modifications.

MARY.

Do these four long planes belong to the primitive crystal?

MRS. L.

No; they are similar, in position, to those which replace the acute angles of the prisms of heavy spar and sulphate of strontian. (fig. 248.) The triangular planes, which terminate the new prism, are primitive faces. The sulphate of barytes exhibits a far greater variety of crystallization than the carbonate; and unless it is nearly opaque, you may see the natural joints in most of it.

FRANCES.

They are very distinct in this specimen: I suppose the cleavage might be easily obtained?

MRS. L.

Yes; it is so brittle, that by letting it fall on the floor you may separate it into fragments similar to the primitive, which is a right prism with rhombic bases (fig. 242.); but more commonly the prism is so low as to appear tabular. (fig. 243.) The crystals are so symmetrical, and the edges so sharp

and perfect, that I think you will have no difficulty in understanding them.

MARY.

How prettily these bluish crystals intersect each other, showing their modifications. (fig. 243.)

FRANCES.

Here are some, very complex (fig. 246), and the planes on the edges are not wider than a hair.

MRS. L.

The large wax-yellow crystals are from Cumberland. (fig. 244.) In some varieties exceedingly thin crystals are aggregated together into roundish masses, and you only see parts of their edges; they are often of a reddish colour.

MARY.

Here is a magnificent crystal (fig. 247); it must be six inches long.

MRS. L.

That is from Cumberland; it is sufficiently thick and transparent to show the double refraction. The columnar structure of these specimens arises from the aggregation of thin, imperfect prisms. The Germans call it *stangenspath* (stick-spar), from the resemblance it has to a bundle of sticks. Fibrous sulphate of barytes has been found at Chaude Fontaine, near Luttich, in the Palatinate; and this dark-brown variety was lately discovered at Boghasen.

FRANCES.

The fibres diverge in the brown specimen.

MRS. L.

Radiated heavy spar is a pretty variety ; it is sometimes called Bolognian spar, because it was first discovered near Bologna.

MARY.

Here is a complete star of crystals.

MRS. L.

This variety is remarkably phosphorescent when heated ; and, after being calcined, has the property of absorbing light ; so that if you expose a piece to the light for a short time, it will be visible in a dark room from the quantity of light which it has absorbed, and again gives out. Sulphate of barytes occurs also with an imperfectly crystalline structure, like marble, and compact.

FRANCES.

This is a good deal like chalk.

MRS. L.

Yes ; the miners call it cawk, it is said, from its resemblance to chalk : the specific gravity of this variety is 4.48. Some of these pieces have thin veins of sulphuret of lead running through them.

MARY.

You said that a white paint was made from barytes ; is it from the sulphate or carbonate ?

MRS. L.

From the sulphate : the carbonate is sometimes



used for poisoning rats. Hepatite is a kind of sulphate of barytes, which, when rubbed, emits a sulphureous smell:—try it.

FRANCES.

The smell is not so strong as in stinkstone; but I think it is worse, if possible.

MRS. L.

It does not crystallize; but the structure is lamellar.\*

MARY.

I am afraid I shall not recollect all these varieties, but the specific gravity is an excellent distinction from other minerals.

MRS. L.

Even that may deceive you in one instance: columnar heavy-spar is so much like carbonate of

\*

|                                    | *<br>Bolognese<br>spar | †<br>Granular<br>Heavy-spar. | ‡<br>Columnar | †<br>Hepatite. |
|------------------------------------|------------------------|------------------------------|---------------|----------------|
| Sulph. barytes . . .               | 62.                    | 90.                          | 96.           | 85.25          |
| Sulphate of lime . .               | —                      | —                            | —             | 6.             |
| Lime . . . . .                     | 2.                     | —                            | —             | —              |
| Strontian . . . .                  | —                      | —                            | 3.10          | —              |
| Silica . . . . .                   | 16.                    | 10.                          | —             | —              |
| Alumina . . . . .                  | 14.75                  | —                            | —             | 1.             |
| Oxyde of iron . . .                | 0.25                   | —                            | 1.50          | 5.             |
| Water . . . . .                    | 2.                     | —                            | 1.20          | —              |
| Loss, including sulphur & moisture | } —                    | —                            | —             | } 2.25         |
| * Afzelius.                        | † Klaproth.            | ‡ Lampadius.                 |               |                |



lead, that it may sometimes be necessary to use chemical means to distinguish them. You may remember, however, that sulphate of barytes, when crystalline or compact, is harder than carbonate of lime.

There is much less diversity in the strontian genus; the carbonate or strontianite is generally very pale green, and radiated or fasciculated, but rarely crystallized.

FRANCES.

Are these acicular crystals, carbonate of strontian?

MRS. L.

Yes; they are hexagonal prisms terminated by pyramids. I do not recollect any thing that is very much like it, except prehnite, which is much harder. But if you are doubtful about a specimen of this appearance, dissolve a little in nitric or muriatic acid: it will effervesce if it be *carbonate* of strontian; and a paper dipped in the solution and dried, burns with a purple flame.

MARY.

That is a pretty experiment, and easily tried. Are these reddish and pale-blue specimens, carbonate of strontian?

MRS. L.

No; they are sulphate: they have a good deal

of resemblance to the sulphate of barytes, but the specific gravity is less,—between 3.6 and 3.7. Haüy named it celestine, from its beautiful light-blue colour. A great deal is found in the neighbourhood of Bristol; but the finest specimens are brought from Sicily.

FRANCES.

Is this fine group of transparent crystals Sicilian? (fig. 248.)

MRS. L.

Yes; and these specimens, where the little crystals are diverging from a mass of sulphur. (fig. 249.)

MARY.

Then it is a volcanic production, I suppose?

MRS. L.

In *this* case it is most likely to be so, from the appearance of the sulphur and the situation in which it occurs. Some of the crystals are very brilliant.

FRANCES.

They appear to be very much like those of the sulphate of barytes.

MRS. L.

Yes; the primitive is a prism which differs very little from that of the barytes\*. Sulphate of

\* The angles of the base of the primitive are  $104^{\circ}$  and  $76^{\circ}$ . Those of sulphate of barytes are  $101^{\circ} 42'$ , and  $78^{\circ} 18'$ .

strontian is sometimes fibrous, like carbonate of lime. It is harder than heavy spar, which will assist you in distinguishing them\*. You have now seen nearly all the natural combinations of earths with each other, and with acids. Can you tell me any properties which characterize the two classes *generally*?

FRANCES.

I do not recollect any description which would apply to them all.

MARY.

I think one property is common to them all, except alum, nitrate of lime, and Epsom salt,—insolubility in water.

MRS. L.

You are right; and the greater part of them have a specific gravity between 2, and 3.5. The next class comprises the compounds of acids with the three alkalis (potash, soda, and ammonia), which are soluble and sapid. Potash has been found combined with nitric acid, forming nitre or salt-

\*

|                | * †<br>Strontianite. |     | ‡ *<br>Sulphate of Strontian. |        |
|----------------|----------------------|-----|-------------------------------|--------|
| Strontian .    | 69.5                 | 62. | 57.64                         | 56.    |
| Carbonic acid  | 30.                  | 30. | —                             | —      |
| Sulphuric acid | —                    | —   | 43.                           | 42.    |
| Oxyde of iron  | —                    | —   | —                             | Trace. |
| Water . . .    | 0.5                  | 8.  | —                             | —      |
| * Klaproth.    | † Pelletier.         |     | ‡ Rose.                       |        |

petre : it occurs as an efflorescence consisting of capillary crystals or flakes, which incrusts chalk and limestone rocks.

FRANCES.

Does it taste like common saltpetre ?

MRS. L.

Yes, but it is not pure ; the nitre of Molfetta contains 30 per cent of carbonate of lime, and 25 of sulphate of lime. In France, nitre is collected from the surface of the chalk near Evreux seven or eight times a year, and it is abundant in several parts of the world.\* Soda is never found pure, but several of its salts occur. Carbonate of soda exists in Egypt on the surface of the earth, and on the margin of some lakes which are dry in the summer.

MARY.

Is it like the soda we use for making saline draughts ?

MRS. L.

No ; it appears of a grey colour, and is very impure : it contains muriate and sulphate of soda. A radiated variety called trona, which is more free from admixture, occurs abundantly near Fezzan in the north of Africa. It is sent principally to

\* In India, Persia, and Arabia, there are large tracts covered with nitre ; and the desert of Nitria or Nitron in Egypt, whence it was named, furnishes abundance of it.

**Tripoli and Egypt\*.** Sulphate of soda is called Glauber salt. It is generally found as an efflorescence in the neighbourhood of mineral springs and salt lakes; sometimes in acicular crystals.

FRANCES.

What is the form of them?

MRS. L.

Generally, imperfect prisms; but if you dissolve the pure sulphate of soda, and suffer it to crystallize, you will obtain hexagonal prisms terminated at each extremity by two planes. A species of sulphate of soda, containing a considerable portion of sulphate of magnesia, is called reussite†: muriate of soda is by far the most abundant of its salts.

MARY.

I think you said that was common salt.

MRS. L.

Yes; but you know that, in general, it undergoes

寒

|                                 | Carbonate<br>of Soda. | Trona. |
|---------------------------------|-----------------------|--------|
| Dry carbonate of soda . . . . . | 32.6                  | 65.    |
| Dry sulphate of soda . . . . .  | 20.8                  | 2.5    |
| Muriate of soda . . . . .       | 15.                   | —      |
| Water . . . . .                 | 31.6                  | 22.5   |

†

[illegible]

the process of refining before it is fit for use: the rock-salt of most countries is intermixed with a quantity of earthy matter, which renders it opake, and gives it a brownish or reddish colour, like this from Cheshire. Sometimes, however, it is very transparent, and quite colourless, as at Cordova in Spain. Here is a crucifix carved in rock-salt.

FRANCES.

How beautifully clear ! I should have taken it for glass.

MRS. L.

The salt-rocks of Cordova are very remarkable ; they are isolated hills, which rise immediately from an extensive plain : some of them are between 300 and 400 feet high. There is a similar hill in the province of Lahore in India : but in most countries salt occurs below the surface of the earth, and is worked like other mines.

MARY.

I remember to have read a description of the salt-mines of Wielitzka, where, it is said, several subterranean chapels have been carved in the salt, all furnished with altars and crucifixes.

MRS. L.

When they are lighted up, they must have a very brilliant appearance ; but I believe the beauty of the salt-mines has been much exaggerated by some travellers. The salt in the lower parts of the mines is much purer than that near the surface of the



earth, and of course whiter and more transparent. Here is a crystallized specimen from Wielitzka.

FRANCES.

Is the cube the primitive form?

MRS. L.

Yes; the cleavage is parallel to the faces of the cubic crystals. The salt is sometimes tinged with a beautiful purplish-blue, but this is not common. There are extensive salt-mines at Soowar in Hungary, in Germany, Siberia, Africa, and indeed in most parts of the world, and in a very elevated part of the Andes; but those of Wielitzka, which are above 600 feet deep, are, I believe, the largest: they have been worked since the year 1251.

MARY.

I had no idea that salt was so abundant.

MRS. L.

Besides the rock-salt, and a great quantity that is collected from the bottoms of lakes which are dry during several months in the year, a great deal is obtained from salt-springs, both in England and other countries: and it constitutes about one thirtieth part of the ocean. Nearly all the margin of the Caspian Sea, for several miles in width, is covered with salt; which it may be supposed is in consequence of its evaporation, as its level is 200 yards lower than that of the Black Sea. Borax, which is soda combined with boracic acid, is found in Thibet and Persia; and, it is said, in China and

Peru. These detached greenish crystals are from Persia. (fig. 251.)

FRANCES.

These are very perfect indeed. What sort of taste has it?

MRS. L.

Its taste is a good deal like bicarbonate of potash, with a slight degree of sweetness. It possesses double refraction; but these crystals are not sufficiently transparent for you to see it.

MARY.

Carbonate, sulphate, muriate, and borate,—are there any other natural salts of soda?

MRS. L.

Yes; a few years since, nitrate of soda was discovered to exist abundantly in Peru. It forms a bed several feet in thickness, in the district of Tarapaca; and in some places it appears at the surface of the earth. In taste, it is cool and bitter; and is deliquescent.

FRANCES.

What is the meaning of that?

MRS. L.

That it absorbs water from the atmosphere and becomes liquid. Large quantities have already been purified and imported into Europe.

Only two salts of ammonia have been discovered in a native state. Muriate of ammonia is commonly called sal-ammoniac. It is a volcanic production,

generally in the state of powder inclosed in lava, but sometimes irregularly crystallized, and either white or tinged with yellow, and very soft. Sulphate of ammonia is mostly of a yellow or yellowish-grey colour, and occurs in crusts on the lava of *Ætna* and *Vesuvius*.

MARY.

How could I distinguish them from each other?

MRS. L.

Dissolve a little of your specimen in water,—the solution, in both cases, will be transparent,—and add a drop or two of muriate of barytes, which is also soluble : if it be sal-ammoniac, no alteration will take place ; but if it be sulphate of ammonia, you will immediately see a white cloud formed, and the solution will appear milky.

FRANCES.

What is the reason of that, Mrs. L. ?

MRS. L.

The barytes combines with the sulphuric acid contained in the sulphate of ammonia, and forms an *insoluble* compound, which is therefore immediately visible ; and the muriatic acid, which is disengaged, unites with the ammonia. This, you see, is a very inconsiderable class compared with the others : you will find the metals much more interesting.

## CONVERSATION XIII.

MRS. L.

BEFORE you look at these specimens, I must say a few words respecting their arrangement. Metals are found either in a metallic state, or combined with sulphur, oxygen, chlorine, or some of the acids. Some of them occur in all these five states, others in only one or two of them.

MARY.

Then I suppose that each metal constitutes a genus, which is subdivided into families of sulphurets, oxydes, &c. ?

MRS. L.

That is not exactly the case; for a few of the metals have been found only in a small proportion in the ores of others; so that we have but twenty-three genera, though there are twenty-eight metals\*. In a metallic state, metals are either pure, or combined with each other, forming alloys. This is their simplest form. The combinations with chlorine are called chlorides; and as chlorine, though formerly considered as one of the acids,

\* Exclusively of the metallic bases of the earths.

differs from them in not containing oxygen, the chlorides are separated from the salts. This table will serve to give you a general idea of the classification.

1st GENUS. (*Gold.*)

FAMILIES. Alloys.

2nd. (*Platinum.*)

FAMILIES. Alloys.

3rd. (*Palladium.*)

FAMILIES. Alloys.

4th. (*Iridium.*)

FAMILIES. Alloys.

5th. (*Tellurium.*)

FAMILIES. Alloys.

6th. (*Mercury.*)

FAMILIES. Alloys—Sulphurets—Oxydes—  
Chlorides.

7th. (*Silver.*)

FAMILIES. Alloys—Sulphurets—Oxydes—  
Chlorides—Salts.

8th. (*Copper.*)

FAMILIES. Alloys—Sulphurets—Oxydes—  
Salts.

9th. (*Iron.*)

FAMILIES. Alloys—Sulphurets—Oxydes—  
Salts.

10th. (*Manganese.*)

FAMILIES. Oxydes—Salts.

11th. (*Uranium.*)

FAMILIES. Oxydes.

12th. (*Cerium.*)

FAMILIES. Oxydes—Salts.

13th. (*Tantalum.*)

FAMILIES. Oxydes.

14th. (*Cobalt.*)

FAMILIES. Alloys—Sulphurets—Oxydes—  
Salts.

15th. (*Nickel.*)

FAMILIES. Alloys—Oxydes—Salts.

16th. (*Molybdenum.*)

FAMILIES. Sulphurets.

17th. (*Tin.*)

FAMILIES. Sulphurets—Oxydes.

18th. (*Titanium.*)

FAMILIES. Oxydes—Salts.

19th. (*Zinc.*)

FAMILIES. Sulphurets—Oxydes—Salts.

20th. (*Bismuth.*)

FAMILIES. Alloys—Sulphurets—Oxydes.

21st. (*Lead.*)

FAMILIES. Alloys—Sulphurets—Oxydes—  
Chlorides—Salts.

22nd. (*Antimony.*)

FAMILIES. Alloys—Sulphurets—Oxydes.



23rd. (*Arsenic.*)

FAMILIES. Alloys—Sulphurets—Oxydes.

Some of these families contain only one species, but others several. Some of the metals are united with oxygen in different proportions.

FRANCES.

Is there any oxyde of iron besides that which is commonly called rust?

MRS. L.

Yes, there are two oxydes of iron; you will see one in its natural state.

MARY.

Gold, I see, is found only in a metallic state; so that there can be no difficulty in knowing it.

MRS. L.

The pure gold, or that which is very nearly so, is easily known; but I am not sure whether you would take this for an ore of gold.

MARY.

Perhaps not; it has more the appearance of brass.

MRS. L.

Brass, you know, is not found in a native state. This has been called brass-yellow native gold, from its colour: it contains about 21 per cent of silver and copper. It does not occur in the form of sand

or grains like the other kind, but generally in small plates and leaves, or dendritic forms.

FRANCES.

Some of this is very pretty ; it is like moss.

MARY.

But does not gold crystallize ?

MRS. L.

Yes ; the gold on some of these specimens is an aggregation of small imperfect crystals ; and they are occasionally found perfect and detached. The best I have seen are in the gold sand found at Mattagrossa in South America. I have put some under the microscope, for the grains are too minute to be seen distinctly without a very high magnifier.

FRANCES.

How very bright they are ! Here is an octahedron with the edges truncated, and a cube ; the edges are not quite sharp.

MRS. L.

I have drawn some of these crystals (figs. 252, 253, 254, 255), which may be derived from the cube or octahedron ; but a great many of them I cannot understand, they seem to be six- and eight-sided prisms, terminated by pyramids. This is a curious macle. (fig. 257.)

MARY.

What crystal is it derived from ?

MRS. L.

Apparently from a cube with truncated angles. (fig. 256.) Here is a piece of selenite containing ramifications of gold. It occurs very frequently intermixed with quartz and iron pyrites, and in large rolled pieces, as well as sand, both in the beds of rivers and in mines. A mass was found in Peru in the year 1730 which weighed 45 pounds.

FRANCES.

What an immense piece !

MRS. L.

I believe it is the largest that has ever been found. A species containing 36 per cent of silver, called electrum, is found in the gold-mines of Schlangenberg in Siberia.

FRANCES.

I did not know that gold was found any where besides India, Africa, and South America.

MRS. L.

It is found more abundantly in those places than other parts of the world ; but there are gold-mines in Spain, Hungary, Transylvania, and many other parts of Europe. Gold, nearly pure, has been found in the stream-works of Cornwall, and at Lead-hills in Scotland : indeed, at one period, the Scotch gold was coined. At Wicklow also, large pieces have occasionally been met with. But the brass-coloured gold is found chiefly in Hungary and

Transylvania. The Hungarian mines are the richest in Europe.—These are grains of platina\*.

MARY.

They are very much like iron.

FRANCES.

I could not have supposed it was so heavy.

MRS. L.

The specific gravity is very great: but crude platina is not so heavy as pure gold, for it contains a small quantity of several metals.

MARY.

I recollect your mentioning that: they are palladium, iridium, rhodium, and one more I believe.

MRS. L.

Osmium. In general these angular grains contain also a minute proportion of iron, copper, and lead; the small flattish ones consist of platina, palladium, and gold. The grains of palladium that occur intermixed with these are very small, and have a radiated texture. There is scarcely any visible difference between the grains of iridium and those of platina; but they are not, like platina, soluble in a mixture of nitric and muriatic acid. None of these metals occur quite pure: they are all found in South America, between the second and sixth degree of north latitude. The only

\* The ore is generally called *platina*; the purified metal, *platinum*.

known European locality of platina is the silver mines of Guadalcanal in Spain.

FRANCES.

You mentioned the other day, when speaking of platina, that Dr. Wollaston had made it into wire so thin that you could hardly see it; and that you would tell us how he measured its diameter: I forget what part of an inch it was.

MRS. L.

The  $\frac{1}{18750}$ th part. The operation was extremely simple:—a hole was drilled through the centre of a thick piece of *silver* wire, into which was fixed a piece of platinum wire of the same length, which fitted the hollow: the two metals were then drawn out together in the usual manner\*; and the silver was dissolved by nitric acid, which has no effect on the platinum. By knowing the original thickness of each wire, and of the silver one after it was reduced, it was easy to know that of the platinum one.

MARY.

Yes, by proportion: but what was the use of making such thin wire?—merely for the sake of experiment, I suppose?

MRS. L.

It might have been done originally with that

\* In order to render wire thinner, it is forced through a small hole in an iron plate. This operation is repeated several times, the hole being smaller each time.

view; but this wire is now substituted in telescopes for threads of the spider's web, which were formerly employed as cross threads: they cannot be too thin for this purpose. Large quantities of platina are consumed in the potteries: you know it is used to cover porcelain and earthenware, in imitation of silver.

FRANCES.

Yes, and they have an advantage over silver, of not tarnishing.

MRS. L.

Well, we have said a great deal about this metal; I believe we may proceed to the next.

FRANCES.

What is it? it has a lighter colour than the platina, or palladium.

MRS. L.

It is native tellurium. There are four alloys of this metal, all found in Transylvania, where they are worked for the gold and silver they contain: this species contains less than the others. Crystals are very rare; and even in this foliated granular state, the metal is not plentiful. The graphic ore of tellurium contains 30 per cent of gold and 10 of silver.

MARY.

Why it is called graphic ore? Can you write with it?

MRS. L.

No; it was so named because it is usually disse-



minated over the earthy minerals which it accompanies, in small prismatic crystals, grouped together so as to have some resemblance to written characters.

FRANCES.

This is much more brilliant than the native tellurium.

MRS. L.

The white or yellow ore of tellurium (it is known by both names) is also very shining: it differs from the graphic ore in containing 19 per cent of lead; and the specific gravity is 10.6: that of the others is scarcely 8. The black ore is very different from the others.

MARY.

Is this it? It is in plates somewhat like mica.

MRS. L.

Yes, but the lustre is perfectly metallic, and it is opaque; and the folia, if sufficiently thin, are flexible, but not elastic like mica. The specific gravity is very nearly 9. All the four species are soft and sectile.

FRANCES.

But would these characters be sufficient to enable me to distinguish a specimen of tellurium from one of any other metal?

MRS. L.

Perhaps not in all cases; but some of its chemical properties are very peculiar: it melts before the blowpipe at rather a low heat, then emits a white smoke, and burns with a green flame till it is

volatilized, and emits a pungent smell resembling that of horse-radish. The gold and silver which are contained in the ores are reduced to a metallic state at the same time. An ore, consisting of tellurium, bismuth, and selenium, has lately been ascertained to exist at Riddarhyttan in Sweden. This is the only instance of the occurrence of tellurium any where except in Transylvania.\* Mercury is the next genus. I dare say you have never seen it in a native state. Here is a specimen covered with little globules.

MARY.

That is very pretty. Some of them are larger than a pin's head.

MRS. L.

Take care not to touch them or shake them off. Mercury in this state is much more rare than the sulphuret, from which most of the quicksilver of commerce is obtained. This is very nearly pure ; but it is sometimes united to silver in sufficient proportion to constitute a solid, or semi-fluid amalgam, which is rarely crystallized in the form of cubes

\* ORES OF TELLURIUM.

|                 | Native | Graphic. | Yellow. | Foliated. |
|-----------------|--------|----------|---------|-----------|
| Tellurium . . . | 92.55  | 60.      | 44.75   | 32.2      |
| Gold . . . .    | 0.25   | 30.      | 26.75   | 9.        |
| Iron . . . .    | 7.20   | —        | —       | —         |
| Silver . . . .  | —      | 10.      | 8.50    | 0.5       |
| Lead . . . .    | —      | —        | 19.50   | 54.       |
| Copper . . . .  | —      | —        | —       | 1.3       |
| Sulphur . . . . | —      | —        | 0.50    | 3.        |
| Klaproth.       |        |          |         |           |

and octahedrons, having their edges and angles truncated. Here is a specimen of it crystallized; and on this it is disseminated in small flakes.

FRANCES.

It is almost as white as silver; but the edges of the crystals are not sharp.

MRS. L.

No: they generally appear a little rounded. There are two species of sulphuret of mercury,—cinnabar, and the hepatic or liver ore.

MARY.

Which is this beautiful crimson red specimen?

MRS. L.

That is cinnabar: it has generally an imperfectly crystalline structure approaching to compact, and is translucent, particularly on the edges: but the crystals are sometimes nearly transparent.

FRANCES.

There are some groups of crystals on this, but they are so small that I cannot make them out.

MRS. L.

The primitive form is an acute rhomboid (fig. 258); but this crystal (fig. 259) occurs more frequently. They are seldom very distinct. Cinnabar is soft, but rather brittle; and if you scratch it with a knife, or any hard substance, the streak is scarlet, which distinguishes it from some other red ores.

Here is another variety, called native vermilion ; it is more of a scarlet colour, and earthy. If you should ever be doubtful about a specimen of cinnabar, you will find the blowpipe useful ; the sulphur burns with a blue flame as soon as it begins to melt, and the mercury is volatilized.

MARY.

What is this, Mrs. L. ; it looks quite glassy?

MRS. L.

That is the hepatic ore : it acquires a brownish colour by exposure to the air ; but when fresh broken, it is of a dark grey inclining to crimson. It is very brittle.

FRANCES.

What is the difference between this and cinnabar ?

MRS. L.

This species contains both iron and carbon \* ;

\*

|                | Cinnabar. | Hepatic ore. |
|----------------|-----------|--------------|
| Mercury .....  | 84.50     | 81.80        |
| Sulphur.....   | 14.75     | 13.75        |
| Charcoal ..... | —         | 2.30         |
| Silica.....    | —         | 0.65         |
| Alumina .....  | —         | 0.55         |
| Iron .....     | —         | 0.20         |
| Copper.....    | —         | 0.02         |
| Water .....    | —         | 0.73         |
| Loss .....     | 0.75      | —            |
| Klaproth.      |           |              |

but it is often intermixed with cinnabar. It occurs in several quicksilver mines, but particularly those at Almaden in Spain, of Idria, and of Siberia. The mines near Almaden have been worked upwards of two thousand years; and those of Deux Ponts, Idria, the Palatinate, and Spanish America, are very considerable. Some of the small roundish masses of compact cinnabar, that are frequently met with, are said to be hollow, and to contain native mercury. The chloride of mercury, which is sometimes called horn quicksilver, is semi-transparent, and nearly colourless.

MARY.

Why is it called horn quicksilver?

MRS. L.

On account of its texture; it is soft and sectile. The crystals are always very small, but in general brilliant; they are square prisms, terminated by flat pyramids, and otherwise modified. Before the blowpipe it is volatilized.

FRANCES.

Are there no more species of chloride of mercury?

MRS. L.

No; and this one is rather scarce.

The silver genus exhibits a good deal of variety; the first family contains native silver and several alloys; but the native silver is the only one of the species which is plentiful.

MARY.

Is it more common than the other ores?

MRS. L.

I believe it is : it forms the greatest part of many of the richest mines, and is occasionally found in immense masses, scarcely intermixed with any of the substances that are generally found in the veins with it. The silver mines of Konigsberg in Norway, which are the most northern in Europe, formerly afforded uncommonly large specimens, from 100 to 150 pounds in weight; and in the mine called Nye Forhaabning one was raised weighing 560 pounds.

FRANCES.

Those would be magnificent specimens for a museum.

MRS. L.

The last I mentioned is still preserved in the royal collection at Copenhagen. The others were probably smelted \*. Some of these specimens are tarnished by exposure to the air; but those which I have covered with a glass, preserve their original whiteness and brilliancy.

\* It is mentioned by Albin, that at Schneeberg, in the year 1478, a rich vein was discovered, and so large a block of native silver ore cut out, that Duke Albert, of Saxony, descended into the mine and used it for a table to dine on. It smelted 44,000 pounds of silver.



MARY.

This is extremely beautiful ; it appears like fern-leaves composed of crystals.

FRANCES.

Yes: and if you look at this one with a glass, you will see some octahedrons.

MRS. L.

Native gold, silver, copper, and all other native metals which crystallize, take the form of the cube, octahedron, and these forms derived from them. (figs. 252 to 256.) Silver is sometimes compact, or nearly so, and very often resembles the branches of fir-trees, particularly that from the mines of Potosi. I think you would be very much pleased with Mr. Sowerby's "Exotic Mineralogy:" every mineral that is described in it, is illustrated by a coloured engraving. It contains some very good representations of the dendritic and arborescent forms of native gold, silver, and copper, as well as of a great many other minerals. Perhaps his work on British Mineralogy, which is executed in the same manner, would be the most useful to you: they are both interesting works.

MARY.

Here are some pieces that seem like masses of silver wire, twisted and interlaced.

MRS. L.

That is not uncommon: the threads (or wires)

are very flexible, for the silver is extremely pure; scarcely ever containing 1 per cent of any other metal. I have native silver in selenite and on purple fluor; but more commonly it is intermixed with limestone or quartz, and pyrites, ores of cobalt and arsenic. The auriferous silver ore contains nearly 30 per cent of gold.

FRANCES.

I suppose it is heavier than common native silver?

MRS. L.

Yes; the specific gravity is above 10.6, but that of native silver does not exceed 10.34; and it is rather yellower than pure silver. This specimen is antimonial silver.

MARY.

Is its grey colour owing to antimony?

MRS. L.

No: it is the effect of tarnish.

FRANCES.

What is tarnish, Mrs. L.?

MRS. L.

Tarnish is a compound of silver, with the sulphuretted and phosphuretted hydrogen gases, which are abundant in all large towns, especially where coals are burnt.

Antimonial silver, in its natural state, is nearly as white as pure silver, but it has less lustre. Before

the blowpipe, the antimony evaporates in the form of a grey smoke. The arsenical and bismuthic silvers are still more rare than this: they contain very little silver, and are merely objects of curiosity. Another alloy has been lately discovered by Berzelius, to which he has given the name of eukairite: it consists of silver, copper, and selenium.

FRANCES.

Have you any of it?

MRS. L.

No: it is very rare. It was found at an old abandoned copper mine at Skrickerum in Smoland: it is described as having a blue colour, and a foliated granular texture. When it is subjected to the action of the blowpipe it melts, and exhales a strong smell of horse-radish, which is characteristic of selenium as well as of tellurium.

These minerals belong to the second family.

MARY.

Are there many sulphurets of silver?

MRS. L.

We are acquainted with four species, which differ from each other, not only in the proportions of silver and sulphur, but in containing a large quantity of some other metal. The silver glance, (or vitreous silver ore, as it is also called,) is a nearly pure sulphuret, of a blackish grey colour: its crys-

tallizations are the same as those of native silver. Here is a beautiful group of crystals with a blue iridescence on the surface; but more commonly it is found in masses, or penetrating the earthy minerals in which it occurs, in various directions.

FRANCES.

Does glance mean sulphuret?

MRS. L.

No: it is a word introduced from the German school of mineralogy, and signifies something bright. But though some of this has a good deal of metallic lustre, the term *glance* is often applied to minerals that have not much claim to it. The specific gravity of this is about 6.9: it is so sectile that you may cut it like lead, which distinguishes it from the antimonial sulphuret.

MARY.

Is that brittle?

MRS. L.

Yes: it has been called brittle silver ore. There is also a variety of sulphuret of silver, which, when in thin plates or crystals, is flexible.

MARY.

Are the crystals different from these?

MRS. L.

Yes: they appear to be derived from a right, oblique-angled prism.

|                | *<br>Auri-<br>ferous<br>silver. | †<br>Anti-<br>monial<br>silver. | †<br>Arseni-<br>cal<br>silver. | †<br>Bis-<br>muthic<br>silver. | †<br>Eukai-<br>rite. | †<br>Sulphuret<br>of silver. | †<br>Antimo-<br>nial sul-<br>phuret. | <br>Cupre-<br>ous sul-<br>phuret. | †<br>White<br>silver<br>ore. |
|----------------|---------------------------------|---------------------------------|--------------------------------|--------------------------------|----------------------|------------------------------|--------------------------------------|-----------------------------------|------------------------------|
| Silver .....   | 72.                             | 77.                             | 12.75                          | 15.                            | 38.93                | 85.                          | 66.5                                 | 52.272                            | 20.40                        |
| Gold .....     | 28.                             | —                               | —                              | —                              | —                    | —                            | —                                    | —                                 | —                            |
| Antimony ..... | —                               | 23.                             | 4.                             | —                              | —                    | —                            | 10.                                  | —                                 | 7.88                         |
| Lead .....     | —                               | —                               | —                              | 33.                            | —                    | —                            | —                                    | —                                 | 48.06                        |
| Arsenic .....  | —                               | —                               | 35.                            | —                              | —                    | —                            | 0.5                                  | —                                 | —                            |
| Bismuth .....  | —                               | —                               | —                              | 27.                            | —                    | —                            | —                                    | —                                 | —                            |
| Iron .....     | —                               | —                               | 42.25                          | 4.3                            | —                    | —                            | 5.                                   | 0.333                             | —                            |
| Copper .....   | —                               | —                               | —                              | 0.9                            | 23.05                | —                            | —                                    | 30.478                            | —                            |
| Selenium ..... | —                               | —                               | —                              | —                              | 26.                  | —                            | —                                    | —                                 | —                            |
| Sulphur .....  | —                               | —                               | —                              | 16.3                           | —                    | 15.                          | 12.                                  | 15.782                            | 12.25                        |
| Silica .....   | —                               | —                               | —                              | —                              | —                    | —                            | 1.                                   | —                                 | 0.25                         |
| Alumina .....  | —                               | —                               | —                              | —                              | 8.9                  | —                            | —                                    | —                                 | 7.                           |
| Loss .....     | —                               | —                               | 4.                             | 3.5                            | 3.12                 | —                            | 5.                                   | 1.135                             | 1.91                         |

\* Fordyce. † Klaproth. ‡ Berzelius. § Sage. || Stromeyer.

FRANCES.

Can you obtain the silver from these ores by means of a blowpipe?

MRS. L.

Yes: the sulphur, and the antimony (which renders the second species brittle), evaporate. The cupreous sulphuret is of a dark lead-colour; it has been found only at Schlangenberge in Siberia. The white silver ore is more abundant. This piece is from Saxony.

MARY.

It is not very white.

MRS. L.

It contains a great deal more lead than silver. These minerals are characterized by a metallic lustre; but this is not the case with all the remaining species.

The red silver ore is a sulphuret of silver and antimony; but it contains a larger proportion of the latter metal, than the brittle silver glance. The dark and light-red varieties differ considerably in appearance, and are, I believe, suspected to differ in composition.

MARY.

This, I suppose, is the light-red variety; it is semitransparent.

FRANCES.

All these specimens seem to consist of very small crystals, some rounded and some perfect; or at least to be covered by them.



MRS. L.

Yes; it rarely occurs in masses, but it has sometimes a dendritic or moss-like appearance. The crystals of dark-red silver ore are exactly similar to these, and much larger.

MARY.

Here are some very perfect hexagonal prisms; are they primitive crystals?

MRS. L.

No, my dear; the primitive form is a rhomboid, rather more obtuse than that of carbonate of lime; and many of the crystallizations of the two substances are very similar. (figs. 260, 261, 262, 263.)

FRANCES.

Most of them, I think: here is a termination like the equi-axe. (fig. 263.)

MARY.

And here is a metastatic dodecahedron (fig. 262), with some other modifications on it.

MRS. L.

Mr. Phillips observes, that the modifications of which the rhomboid is susceptible seem to be almost unlimited. He has ascertained on a single crystal of this mineral, sixteen; one of which tends to produce an acute, another an obtuse, rhomboid; five, which if complete, would form obtuse dodecahedrons; nine, acute octahedrons, and two six-sided prisms.

FRANCES.

I see that many of these crystals are very complex.

MARY.

But, Mrs. L., these are very nearly black and opake, and the lustre almost metallic.

MRS. L.

The colour is very deep; but a small fragment is strongly translucent, and the colour a bright blood-red, like the other kind. This ore melts before the blowpipe and fumes like antimony, and sometimes the sulphur it contains burns away with a blue flame.

FRANCES.

Is it common?

MRS. L.

Yes, it is rather abundant in the mines of Germany and Mexico.

MARY.

I believe there is a chloride of silver too?

MRS. L.

Yes; it is a little like the chloride of mercury, but occurs in much larger masses and crystals.

FRANCES.

This is a very large cube, it appears nearly transparent internally; does it acquire this thin grey crust by keeping?

MRS. L.

Sometimes it is found coated in this way. It is so soft that you may stick a pin into it: you may try the experiment on this little greenish specimen.

MARY.

It feels like sticking it into wax.

MRS. L.

It is very splendid where it has been broken or scratched; but in some parts it appears earthy, as if it might be easily crumbled.

FRANCES.

It is a very curious mineral; what is the specific gravity of it?

MRS. L.

It is about 4.8. In the European mines it occurs sparingly, but in some parts of South America it is plentiful. The buttermilk silver ore which is found at Andreasberg in the Hartz is a variety of this substance. The name arose from its being sometimes in a semi-fluid state. The only natural salt of silver at present known is a carbonate containing antimony; it is grey, soft, and shining, and effervesces with nitric acid: it is found only in a mine at Altwolfatch in the Black Forest. You will find in the examination of metallic minerals that the blowpipe is extremely useful; the results are in general so well characterized, and so easily obtained.

MARY.

I wish, Mrs. L., you would have the goodness to give us some little scraps of the minerals we have seen, to examine chemically: I should like to try how well I can recollect what you have told us of them.

MRS. L.

I will do that willingly; and as you cannot yet be very expert in using the blowpipe, I would re-

commend you to use charcoal as a support for them: it is particularly useful in the reduction of oxydes, because it absorbs the oxygen, and assists in decomposing them. The next genus will afford you a good opportunity of exercising your chemical knowledge.

FRANCES.

Is there a greater variety of copper ores than of silver ores?

MRS. L.

Yes; there are several sulphurets, and a great many salts: you will find the copper genus a very interesting one.

## CONVERSATION XIV.

MRS. L.

THE native copper is found unalloyed, except with a trace of iron and gold \*.

MARY.

Some of these specimens are very bright; there could be no difficulty in knowing them to be copper.

MRS. L.

They are chiefly from Cornwall, Siberia, and Saxony. Some of the crystals are good, but they do not occur very frequently. It is most commonly found in masses that have a confused and imperfect crystallization, with large interstices, or in irregular plates: here is one of that kind, partly coated with red oxyde of copper.

FRANCES.

This has none of the lustre or colour of pure copper; how would you know it?

\* According to the analysis of Dr. John: the specimen was from Ekaterineburg.

MRS. L.

By its weight, and degree of flexibility; and by scratching it, which would show the hardness, colour, and lustre.

MARY.

What is the green part of this specimen?

MRS. L.

It is probably carbonate of copper; but the native copper is more frequently intermixed with the red oxyde, or dispersed through quartz or carbonate of lime. The purest sulphuret of copper is called copper glance, and some of it is very brilliant; but the finest and largest crystals are mostly dull and blackish.

FRANCES.

These are double pyramids, I believe. (fig. 265.)

MRS. L.

Yes: they are derived, like the triangular dodecahedron of quartz, from a rhomboid; but in the sulphuret of copper the rhomboid is acute. This however is ascertained by cleavage. The simplest form in which it occurs is a hexagonal prism. (fig. 264.)

MARY.

The little bright crystals are mostly very thin hexagonal tables, and look as if they would split.

MRS. L.

They may be cleaved parallel to the bases of the



prisms or tables. But you may frequently observe a conchoidal cross fracture.

FRANCES.

This has a conchoidal fracture, but it is not crystallized : is it the same substance ?

MRS. L.

Yes ; it often occurs massive, both in Cornwall and Germany, and in other parts of the world. The hardness of copper glance is variable ; sometimes it is soft and sectile : other varieties are rather brittle.

MARY.

How very strange it appears, that a mixture of sulphur and copper should be of this deep grey colour. These things seem to me a great deal more curious than the compounds of the earths, though perhaps they are not so in reality.

MRS. L.

It is because you are so much more accustomed to see many earthy minerals, such as marbles, serpentine, agates, and precious stones, in almost a natural state, without thinking of how many substances they are composed : but the metals which you see in common use are mostly simple substances, derived from natural combinations with which you are scarcely acquainted. These sulphurets are sectile, and the specific gravity is about 5 or 5.4. The second species is the variegated copper ore.

FRANCES.

What beautiful colours! Would you not call this iridescent?

MRS. L.

Yes; some parts exhibit all the colours of the rainbow.

MARY.

But they do not seem to be the original colour of it?

MRS. L.

No; they are a tarnish acquired by exposure to the air: the original colour is a little browner than that of copper. The crystals are usually cubes having the angles truncated: and it frequently occurs in a botryoidal form. Copper pyrites often exhibits a similar iridescence.

FRANCES.

I suppose it must be a very abundant mineral; I have seen it with many others.

MRS. L.

Yes; it is by far the most common ore of copper, and occurs in a variety of forms, but usually massive or crystallized: the primitive form is an acute octahedron with a square base (fig. 268), which however has not hitherto been seen in a natural state; but it may be obtained by cleavage without much difficulty.

MARY.

These crystals appear to be derived from a te-

trahedron; I do not exactly see their connexion with the primitive.

MRS. L.

A tetrahedron of which the solid angles are truncated, is in fact an octahedron, with four large and four small faces; and this (fig. 270) arises from the replacement of the pyramidal edges of the primitive octahedron. (fig. 269.)

MARY.

How curiously the faces of these crystals are curved.

MRS. L.

That is not an uncommon circumstance in the crystals of copper pyrites. They are often found covered with a thin blackish or grey coating; the colour of the fracture is generally brass-yellow.

FRANCES.

Is this pyrites too, Mrs. L.? it has a botryoidal form.

MRS. L.

Yes; the colour is deeper, and the fracture duller and more compact than in the crystallized pyrites, and it is harder and more brittle; which is also the case with the amorphous or massive variety, which occurs disseminated through quartz. These crystals are intermixed with crystals of copper glance.

MARY.

What is the difference between this and the variegated copper ore?

MRS. L.

Copper pyrites contains more iron and sulphur in proportion to the copper, than the other species; sometimes above 40 per cent of iron. Both may be scratched by a knife, a property by which it may easily be distinguished from iron pyrites: they are often seen together. White copper ore, which is the rarest in this family, resembles this last species except in colour.

FRANCES.

What are these crystals, Mrs. L.? not white copper I should think? (figs. 271, 272.)

MRS. L.

No; they are grey copper ore: its crystallizations appear to be derived from the regular tetrahedron.

MARY.

Does it consist of any other substances than copper, sulphur, and iron; or are they only combined in other proportions?

MRS. L.

There are two kinds of grey copper ore: one containing arsenic; the other composed of the same elements as the last two species, but containing a larger quantity of copper.

MARY.

I suppose then that the blowpipe would distinguish the arsenical variety?

|   | *<br>Copper-Glance. | †<br>Variegated<br>copper ore. | §<br>Copper<br>pyrites. | <br>Grey cop-<br>per ore. | **<br>Tennantite. | ††<br>Black copper ore. |
|---|---------------------|--------------------------------|-------------------------|---------------------------|-------------------|-------------------------|
| Copper .....  | 78.5                | 58.                            | 41.0                    | 42.5                      | 45.32             | 39.                     |
| Iron .....  | 2.25                | 18.                            | 17.1                    | 27.5                      | 9.26              | 7.5                     |
| Arsenic .....   | —                   | —                              | —                       | 15.6                      | 11.84             | —                       |
| Antimony .....  | —                   | —                              | —                       | 1.5                       | —                 | 19.5                    |
| Silver .....  | —                   | —                              | —                       | 0.9                       | —                 | —                       |
| Sulphur .....   | 18.5                | 19.                            | 45.1                    | 10.                       | 28.74             | 26.                     |
| Oxygen .....  | —                   | 5.                             | —                       | —                         | —                 | —                       |
| Mercury .....   | —                   | —                              | —                       | —                         | —                 | 6.25                    |
| Silica .....  | 0.75                | —                              | —                       | —                         | —                 | —                       |
| Earthy matter ...   | —                   | —                              | —                       | —                         | 5.00              | —                       |
| Loss .....  | —                   | —                              | —                       | 2.0                       | —                 | 1.75                    |
| * Klaproth. † Brande. ‡ Klaproth. § Lampadius.    Klaproth.<br>†† Phillips. |                     |                                |                         |                           |                   |                         |

MRS. L.

Yes ; it gives a white smoke : you must not expose it to a great heat at first, because it crackles very much. Tennantite\* seems to differ from grey copper ore, in containing more sulphur and less iron, and in being harder. The crystals, which are usually very small, are derived apparently from the regular octahedron, and are harder than those of grey copper. Black copper ore is the black oxyde, which generally occurs as a thin earthy crust, coating other ores.

FRANCES.

I think you once mentioned another oxyde of copper, which crystallized in a great variety of forms?

MRS. L.

Yes ; the red oxyde, or ruby copper ore. I have a great many specimens of it, chiefly for the sake of the crystallizations they exhibit : some of the crystals are semitransparent.

MARY.

The light-coloured varieties are very much like red silver ore.

MRS. L.

Yes, in colour ; but the crystals are generally more perfect than in light-red silver ore. The primitive form is the regular octahedron ; but it

\* Discovered by Mr. Phillips in some Cornish copper-mines near Redruth.



cannot be easily obtained by cleavage. It would be useless for you at present to examine all the little crystals that I have detached. Mr. Phillips has enumerated about a hundred varieties produced by the combinations of nine modifications.

FRANCES.

That is a great number, indeed: but as the modifications are so much fewer than in carbonate of lime, I should think the derivation of the crystals from the primitive would be more easily traced.

MRS. L.

Yes; and you may frequently recognise some of the faces of the octahedron, though it is often distorted by the extension of some of the planes. I believe all these forms occur in Cornwall. (fig. 273 to 283.) The crystals are generally very small, except the detached ones found at Chessy in France which are all coated, like these, with green carbonate of copper.

MARY.

I do not see any maced crystals.

MRS. L.

No; it is possible that they exist, but I have never observed any. The most beautiful variety is the *capillary* red copper ore; the colour is brilliant carmine red, and on this account it has been called carmine copper: the cavities in this specimen are filled with it. You see the thin square prisms

generally intersect at right angles; but sometimes they form divergent tufts. The beautiful crimson colour you have seen in old stained glass is occasioned by oxyde of copper; formerly, it was thought that it could only be produced by gold. The third species, containing a good deal of red oxyde of iron, is called tile ore, from its appearance and colour; it is nearly infusible before the blowpipe, and the proportion of copper it contains varies from 10 to 50 per cent.

Among the salts of copper, the family of carbonates offers perhaps the greatest variety; the malachite you admired so much is one of its species.

MARY.

It is a beautiful mineral; I should like to see some that is not cut and polished.

MRS. L.

Well, here are a great many specimens, fibrous, earthy, and compact.

FRANCES.

I suppose this is compact.

MRS. L.

Yes; if it were cut, it would have the same appearance as that you saw in the Museum; the external form is botryoidal, and the structure concentric lamellar; so that when it is cut, it appears marked with concentric rings, or parts of

circles, alternately light and dark. Here is a piece where the surface appears almost entirely composed of hemispheres; and the concretions are so distinct, that they seem to be a collection of little cups, fitting into each other.

MARY.

That is a beautiful example of the structure.

FRANCES.

This specimen seems to have been formed like a stalactite, though it consists of concentric shells.

MRS. L.

Yes; and if you examine the fracture, you will see that it is very delicately fibrous, the fibres diverging from the centres of the concretions. In the massive malachite this fracture passes into conchoidal, but there is scarcely any lustre except in the fibrous variety.

MARY.

Are these beautiful little tufts of a dark bright green colour, fibrous malachite?

MRS. L.

Yes, they are delicate capillary crystals, which are sometimes aggregated into small masses in the manner of zeolite; their lustre is very silky.

FRANCES.

But are the crystals never larger than these?

MRS. L.

Yes; here is a group where they are from half an inch to an inch in length, but they are extremely scarce: these are from Saxony. The finest specimens of compact malachite are brought from Siberia: most of that found in the Cornish mines is very pale and earthy, sometimes incrusting the massive red oxyde.

MARY.

What are these blue crystals, Mrs. L.?

MRS. L.

They are blue carbonate of copper; some varieties are very beautiful.

FRANCES.

The crystals seem to be similar to those of malachite.

MRS. L.

It is conjectured that the crystals of malachite have once been blue carbonate of copper, as they differ very little in composition; the malachite contains the greatest proportion of water. The rhombic prisms, nearly similar to obtuse rhombs, which are found at Chessy, are considered to be primitive crystals, though they may be cleaved in three other directions. The dark ones have a rich purple tint, but the light-coloured varieties are nearly pure blue.

MARY.

I recollect admiring very much a large specimen

in the Museum, called velvet copper ore, of a brilliant light-blue colour.

MRS. L.

It is found only at Oravicsa in the Bannat, forming a velvety crust on malachite and brown ironstone; the name is very characteristic: it is arranged as a distinct species at present, for it has not yet been analysed. The finest specimens of indurated blue copper ore are from Chessy and Siberia. Some of these crystals are semitransparent and very brilliant; the larger ones are only faintly translucent on the edges: sometimes they are aggregated into little balls and irregular roundish forms.

FRANCES.

But does it never occur compact like malachite?

MRS. L.

It is sometimes massive, but the texture is earthy and porous; and it is not sufficiently hard to be used for any ornamental purpose, like malachite. All the carbonates may be scratched with a knife, and their specific gravity is about 3.5, except the anhydrous carbonate, which is much lighter. Its specific gravity is 2.62. It is of a blackish-brown colour, and opaque, generally containing quartz crystals and a mixture of other copper ores. It was discovered in India some years ago.

MARY.

What is this, Mrs. L.? the green is bluer, and less pleasing than in the other specimens.

MRS. L.

It is chrysocoll\* ; a species containing less carbonic acid and silica than the others. It differs too in some external characters from the compact malachite, and has a shining vitreous lustre. The dark dull green which is intermixed with it is called iron-shot copper-green. Chrysocoll effervesces with acids much more slowly than the other carbonates.

FRANCES.

Will the blowpipe reduce it to copper ?

MRS. L.

Not without the addition of borax or some other flux : while melting, it tinges the flame green. Most of the copper ores will give a green colour to the flux, before they are reduced.

There are two species of silicate of copper—these little fragments are called diopase.

MARY.

Do not you think they might easily be mistaken for emeralds ?

MRS. L.

Yes, at first sight, particularly as the crystal is a hexagonal prism ; but the terminations (which are very seldom perfect) are the summits of a rhomb which is the primitive (fig. 286.) ; and it is

\* Sometimes called Copper-green, or Mountain-green.



scarcely hard enough to scratch glass : it has been called emerald copper ore. The other species is a carbonate combined with silica, which I have not seen.

The next family contains the arseniates of copper ; all of which are found in Cornwall ; and I believe, except the ferruginous species, in no other country.

MARY.

Are there many species ?

MRS. L.

We are acquainted with four, which differ from each other both in composition and crystalline form ; besides the martial or ferruginous arseniate, and another which has not been analysed.

The greenish-blue crystals on this specimen belong to the lenticular or octahedral arseniate.

FRANCES.

They appear to be very flat octahedrons with a square base : why are they called lenticular ?

MRS. L.

When the primitive crystal is modified, as in this case (fig. 288), it often appears rounded, and has some similarity to a lens. The colour of the next species is a much more pleasing green.

MARY.

Are these little shining plates, like mica, the copper ore ?

MRS. L.

Yes; they are hexagonal, but not hexagonal prisms.

FRANCES.

How can that be?

MRS. L.

The lateral planes (or edges) are trapeziums, which incline alternately contrary ways : and if you divide an acute rhomb, which Mr. Brooke has shown to be the primary form of this variety, by planes perpendicular to its axis, you will obtain similar plates. (fig. 290.)

This variety will scratch gypsum, but not calcspar. Both kinds are strongly translucent ; the first contains 35 per cent of water, this only 21. The dark olive-green crystals on those specimens are a variety of the oliven ore, a name it received from its colour.

MARY.

I cannot distinguish the form of them ; they seem to be the summits of crystals arranged in radiated tufts.

MRS. L.

You are right ; where the tufts are broken, you may see the radiated structure. The single crystals are represented by this model (fig. 292), the primitive is a right rhombic prism. (fig. 291.) But some of these are quite large enough for you to distinguish their form, even without a magnifier.

Another variety of oliven ore, considerably resembling this, occurs in the form of irregular octahedrons, derived from an oblique rhombic prism. (figs. 293, 294.)

FRANCES.

These two species appear very much alike. I think, when the crystals are small, it must be difficult to distinguish them.

MRS. L.

The right rhombic arseniate generally occurs in longer and more slender crystals than the other: the oblique rhombic often presents brilliant surfaces which are sometimes curved; and it is of a darker colour. The former of these two is an anhydrous arseniate.

MARY.

If these minerals are exposed to the blowpipe, will the arsenic acid evaporate in a white smoke?

MRS. L.

There will be scarcely any smoke, but you will perceive a smell of garlic, which is peculiar to arsenic.—They melt at first into a black porous scoria; and if you continue to melt this, with the addition of borax, you will obtain a bead of copper. The fibrous arseniate is perhaps merely a variety of the oliven ore, in delicate filamentous crystals. The fibres are extremely slender, and it sometimes approaches to a fine earthy texture. All the species

are found with quartz, which generally fills the spaces between the crystals.

FRANCES.

Are the crystals on this specimen, oliven ore too? (fig. 295.)

MRS. L.

No; they are called martial arseniate: they contain iron, and are always light blue. Skorodite is most probably the same substance. It resembles it in colour; and the inclinations of the faces, according to the reflective goniometer, agree very nearly in both minerals. Very small but perfect crystals, of a dark bottle-green colour, have lately been discovered in Cornwall.

This is rather an unimportant family, as no use is made of any of the species.

MARY.

Are they never worked as copper ores?

MRS. L.

No; they are found in too small a quantity; and to separate the arsenic acid would be a difficult and tedious operation.—These specimens are muriate of copper. It was first discovered in Peru, in the form of a brilliant green sand, intermixed with small quartz crystals.

FRANCES.

It is very much like diopase in colour and translucency; how could I distinguish them?

|                           | * Blue<br>carbo-<br>nate. | * Mala-<br>chite. | * Moun-<br>tain-<br>green. | † Sili-<br>cate. | † Octahedral<br>Arsenate | † Rhom-<br>boidal<br>arsenate. | † Oblique<br>pris-<br>matic. | † Right<br>prisma-<br>tic. | †<br>Martial<br>Arsenate. |
|---------------------------|---------------------------|-------------------|----------------------------|------------------|--------------------------|--------------------------------|------------------------------|----------------------------|---------------------------|
| Oxide of Copper . . . .   | 70.                       | 70.5              | 50.                        | 55.              | 49.                      | 58.                            | 54.                          | 60.                        | 22.5                      |
| Oxide of Iron . . . . .   | —                         | —                 | —                          | —                | —                        | —                              | —                            | —                          | 27.5                      |
| Carbonic acid . . . . .   | 19.                       | 18.               | 7.                         | —                | —                        | —                              | —                            | —                          | —                         |
| Arsenic acid . . . . .    | —                         | —                 | —                          | —                | 14.                      | 21.                            | 30.                          | 39.7                       | 33.5                      |
| Muriatic acid . . . . .   | —                         | —                 | —                          | —                | —                        | —                              | —                            | —                          | —                         |
| Phosphoric acid . . . . . | —                         | —                 | —                          | —                | —                        | —                              | —                            | —                          | —                         |
| Silica . . . . .          | —                         | —                 | 26.                        | 33.              | —                        | —                              | —                            | —                          | 3.                        |
| Water . . . . .           | 2.                        | 6.                | 17.                        | 12.              | 35.                      | 21.                            | 16.                          | —                          | 12.                       |
| Loss . . . . .            | 2.                        | —                 | —                          | —                | —                        | —                              | —                            | —                          | —                         |

\* Klaproth.

† Lowitz.

‡ Chenevix.

MRS. L.

Muriate of copper is soluble, both in nitric and muriatic acid; the diopase in neither: besides, their crystallization is very different. (figs. 296, 297.)

The small shining octahedrons scattered over this piece of quartz are phosphate of copper.

MARY.

They are very similar to something I have seen before,—pleonaste, I think.

MRS. L.

They are a good deal alike; but these are *rectangular* octahedrons, and the fracture is diverging fibrous. A hydrous phosphate of copper has also been found on the banks of the Rhine, which is crystallized in small divergent prisms; or massive, having a fibrous and somewhat radiated structure. On charcoal, it may be fused by the blowpipe into a reddish black slag; and by the addition of carbonate of soda, it may be reduced to a bead of pure copper. Sulphate of copper is a soluble salt, which I dare say you have seen; it is commonly called blue vitriol.

|                             | *Anhydrous<br>Phosphate. | †Hydrous<br>Phosphate. |
|-----------------------------|--------------------------|------------------------|
| Oxyde of Copper . . . .     | 68.13                    | 62.487                 |
| Phosphoric Acid . . . .     | 30.95                    | 21.687                 |
| Water . . . . .             | —                        | 15.454                 |
| * Klaproth. † Rev. F. Lunn. |                          |                        |



FRANCES.

Yes, I have ; it is a fine blue, inclining to purple, and the crystals are rather flat.

MRS. L.

The natural crystals are small, and rarely perfect. They occur intermixed with copper pyrites and earthy matter. You have now seen nearly all the copper ores ; some of them are very abundant, but the greater number are found sparingly.

MARY.

There is a great deal of variety in their appearance, but I cannot help thinking that I should know most of them if I were to see them again.

MRS. L.

Most of the species are well marked ; and where the external characters are variable, you will find the chemical ones very satisfactory. To-morrow you will see the iron ores.

## CONVERSATION XV.

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MARY.

AMONG the ores of iron, is there any native iron?

MRS. L.

Yes; but it is scarce, compared with many of its combinations, such as pyrites and the red oxyde. There are two kinds of native iron,—terrestrial, and meteoric; that is, iron which has fallen through the atmosphere.

FRANCES.

I have often heard of showers of stones, but never could learn where they came from.

MRS. L.

The original situation of meteoric stones has been frequently discussed; but I believe without their appearance being satisfactorily accounted for. It has been supposed by some that they are formed in the air, from particles that are constantly floating in it. However this may be, there is no reason to doubt their aërial descent, as several masses, both of stones and iron, have been seen to fall in different parts of the world; and judging from the similarity of their appearance and composition, the masses of

native iron found in the desert of Sahra, in Siberia, Mexico, and South America, are supposed to have had the same origin.

MARY.

Then I suppose this is not quite pure iron ?

MRS. L.

No; it is a remarkable fact, that all the meteoric iron contains a quantity of nickel, from 3.5 to 10 per cent; but it is not sufficient to alter its appearance or malleability: and you see this piece has become slightly oxydated, like any other iron.

FRANCES.

Has meteoric iron always this cellular or corroded appearance ?

MRS. L.

No; that appearance is, I believe, peculiar to the native iron of Siberia: the exterior of the mass at the Cape of Good Hope is quite smooth, and for a long time was called an old anchor by persons who had no knowledge of its real nature. When the Emperor of Russia was in England, Mr. Sowerby presented to him a small sword made of it. It occurs in many parts of the world\*. The Esquimaux discovered by Captain Ross in his Arctic expedition had knives made of iron, which contained 3.5 per

\* A tract of land many leagues in extent, thickly strewed with large masses of meteoric iron, has lately been discovered in South America by M. Aimé Bonpland.

cent of nickel; and from the description of the appearance and situation of the original blocks, they are considered to be meteoric. Terrestrial native iron is far more rare; small pieces have been occasionally found in the scoria of extinct volcanoes.

Of the sulphuret of iron, there are two species; this kind is magnetic.

MARY.

Will it attract needles as a magnet does?

MRS. L.

No; but it will attract the polar magnet. It is generally of this reddish or bronze-yellow colour; and massive, or imbedded in limestone, quartz, or mica-slate, with other minerals, and ores of iron: it is sometimes crystallized in hexagonal prisms and pyramids.

FRANCES.

Will not these bright-yellow crystals attract the magnet?

MRS. L.

No; they are common pyrites, which contains much more sulphur than the first species. This is divided into several subspecies; but Comte Bournon is of opinion that analysis will some day prove that there are at least two (if not more) species united under the name of cubic pyrites; because, after examining the cleavage of a great many crystals, he found the primitive to be sometimes a cube, and sometimes an octahedron.

MARY.

The faces of all these cubes, I see, are streaked in a particular direction. (fig. 301.)

MRS. L.

All these crystals (figs. 302, 303, 304) are derived from the striated cube; those streaks (fig. 301) are parallel to certain edges of the pentagonal dodecahedron, which are situated over the planes of the cube. Here are cubes, of which the faces are quite smooth, and probably the octahedron is their primitive form. The most brilliant pyrites is that found in Peru: the early inhabitants appear to have made mirrors of it; in consequence of which it was named *Piedra de los Incas*.\* The other varieties are cellular and capillary, which are rather scarce; and radiated pyrites which occurs more abundantly, in small stalactitic and botryoidal masses. I dare say you may have seen them on the sea-shore, where the cliffs are of clay or chalk, as they are originally imbedded in them; they are sometimes called thunderbolts.

FRANCES.

Yes; I think I have seen some, but I forget where.

MRS. L.

Very likely in the Isle of Wight; but they occur in Derbyshire and many other places.

\* Iron pyrites is often called marcasite by the miners.

MARY.

Most of these have a dark-brown crust. Is that different from the yellow radiated part?

MRS. L.

Yes, it is produced by the action of the atmosphere, which decomposes the pyrites so much, that the iron it contains becomes oxydated—that is, in fact, rust of iron. The specific gravity of iron pyrites varies very little; it is generally 4.7; but it is a mineral so well characterized, that you will hardly find it necessary to refer to that property, to distinguish it: it will give sparks with steel in the manner of flint. The first species of oxyde of iron is the magnetic ironstone.

FRANCES.

I suppose this is the *black* oxyde. I recollect you told me there were two kinds, black and red.

MRS. L.

Yes, but this is a chemical compound of the two oxydes; it is most commonly granular, or approaching to compact; but sometimes it occurs in octahedrons and rhomboidal dodecahedrons, which are in general small and greyish-black, and imbedded in chlorite. I have put some needles on one of the specimens, and if you lift it up, you will find that they adhere very firmly.

MARY.

Yes, they do.



FRANCES.

This then is not only magnetic, but has polarity?\*

MRS. L.

Yes; but it is very singular that it has not this property till some time after it is taken from its original situation, or unless it lies near the surface of the earth. There are very extensive mines of it in Sweden, particularly at Dannemora, where the bed which is worked is several hundred feet thick. It is very abundant in Saxony also.

MARY.

Is it never found in England?

MRS. L.

Small quantities have been met with in Cornwall and Devonshire, but it is not considered of importance as an English iron ore.

FRANCES.

How beautiful *these* specimens are! Look at those brilliant colours—are they magnetic iron ore?

|              | *      *     |       | †                | †                    |
|--------------|--------------|-------|------------------|----------------------|
|              | Native-Iron. |       | Iron<br>Pyrites. | Magnetic<br>Pyrites. |
| Iron . . . . | 96.5         | 96.75 | 47.5             | 63.5                 |
| Nickel . . . | 3.5          | 3.25  | —                | —                    |
| Sulphur . .  | —            | —     | 52.5             | 36.5                 |
| * Klaproth.  |              |       | † Hatchett.      |                      |

\* See vol. i. page 89.

MRS. L.

They are specular iron ore; which is sometimes, but not always, magnetic. It is also called iron-glance. Those beautiful colours are not essential to the substance, but are a superficial tarnish, like that on tempered steel; internally the colour is steel-grey. The finest specimens are found in the Isle of Elba, where it is more plentiful than any where else; the mines there have been worked about 3000 years.

MARY.

It has very much the appearance of steel; is it hard?

MRS. L.

Yes, and rather tough; but you can scratch it with a knife, and the streak appears of a deep blood-red colour: the variety called iron-mica occurs in splendid hexagonal plates, so thin, that by holding them in the sunshine you will find they are semitransparent.

FRANCES.

Yes, they are a fine deep-red colour. The plates are streaked in three directions parallel to the sides of the hexagon.

MRS. L.

The primitive form is an acute rhomboid differing very little from a cube. The crystals of Elba iron-glance are seldom very perfect, and therefore not easily understood (figs. 305, 306, 307); they are

derived from the same primitive as the plates of the micaceous iron ore.

MARY.

Can the iron be separated from the oxygen in these ores by the blowpipe?

MRS. L.

No; the process for obtaining iron from them is much more tedious than that used with some other ores. The titaneous iron ore, which is compact, and of a colour inclining to reddish brown, is found in Sweden and Norway. It affects the magnet very slightly; it is oxyde of iron containing oxyde of titanium mechanically intermixed with it.

FRANCES.

Are there any more black iron ores?

MRS. L.

No; these are varieties of the red oxyde. Three of them, the scaly, the compact, and the fibrous, are so nearly pure oxyde\* of iron, that the other constituents cannot be considered essential to them, or of any importance; but the red ochre is very impure, containing a great proportion of clay.

MARY.

I suppose this is the ochre; it looks like clay strongly coloured by iron.

\* *Peroxyde*, signifying that which contains the greatest proportion of oxygen: the black oxyde is called *protoxyde*.

FRANCES.

Is this red oxyde of iron? the colour is extremely deep.

MRS. L.

Yes, it is the compact kind, the colour approaches to grey; but the fibrous variety is frequently blood-red: this is generally called hæmatite.

MARY.

The structure of this is similar to that of malachite, except that in some of these specimens the fibres are so very long.

MRS. L.

But there is very seldom any appearance of concentric lamellar formation in hæmatite. The burnishers used in the Birmingham manufactories for polishing gilt buttons are made of this substance. The scaly red ironstonehair\* is the least abundant; it consists of fine scaly particles with a faint lustre which soil strongly: the other kinds are the most abundant of the English iron ores†. This dark-brown shining mineral is called stilpnosiderite: it is a subspecies of the hydrate of iron.

FRANCES.

How very resinous the lustre is: it is a good deal like pitchstone, except in being opaque.

\* Or red iron froth.

† All the Lancashire and great part of the Leicestershire iron ores are of this kind.

MRS. L.

And the specific gravity is nearly 3.8. It is hard, but a knife will scratch it, and the streak is yellowish brown: it is found in Father Abraham's mine at Schiebenberg in Saxony.

MARY.

This specimen is exactly like hæmatite except in colour.

MRS. L.

It is called brown hæmatite; but the fibres are never long, as they sometimes are in the red hæmatite. The compact, and fibrous brown ironstone sometimes occur in pseudo crystals, but they are rare. You may remember to have seen the brown hæmatite with some of the copper ores; they frequently occur together. This, which is the ochry\* hydrate, is found in great plenty in England.

FRANCES.

Is it not yellow ochre?

MRS. L.

Yes; it is very extensively used in house-painting, to make stone-colours and olive-greens, and for colouring whitewash. The globular hydrate is distinguished into lenticular, kidney-form, and pisiform (or pea ironstone), according to its external shape. The last variety consists of roundish grains aggregated together.

\* Ochry-brown ironstone.

|                          | *<br>Ironmica. | †<br>Iron<br>froth. | †<br>Red hæ-<br>matite. | §<br>Stilpno-<br>siderite. | <br>Brown<br>hæmatite. | <br>Compact<br>brown<br>ironstone. | <br>Lenticu-<br>lar hy-<br>drate. | <br>Iron ochre | <br>Meadow<br>ore | * *<br>Umber |
|--------------------------|----------------|---------------------|-------------------------|----------------------------|------------------------|------------------------------------|-----------------------------------|----------------|-------------------|--------------|
| Peroxyde of iron . . . . | 94.38          | 94.5                | 90.                     | 80.5                       | 82.                    | 84.                                | 73.                               | 83.            | 61.               | 48.          |
| Oxyde of manganese       | —              | —                   | Trace.                  | Trace.                     | 2.                     | 1.                                 | 1.                                | Trace.         | 7.                | 20.          |
| Silica . . . . .         | —              | 4.25                | 2.                      | 2.25                       | 1.                     | 2.                                 | 9.                                | 5.             | 6.                | 13.          |
| Alumina . . . . .        | —              | 1.25                | —                       | —                          | Trace.                 | —                                  | —                                 | —              | 2.                | 5.           |
| Lime . . . . .           | —              | —                   | 1.                      | —                          | —                      | —                                  | —                                 | —              | —                 | —            |
| Phosphate of lime . .    | 2.75           | —                   | —                       | —                          | —                      | —                                  | —                                 | —              | —                 | —            |
| Magnesia . . . . .       | 0.16           | —                   | —                       | —                          | —                      | —                                  | —                                 | —              | —                 | —            |
| Stony matter . . . . .   | 1.25           | —                   | —                       | —                          | —                      | —                                  | —                                 | —              | —                 | —            |
| Water . . . . .          | —              | —                   | 3.                      | 16.0                       | 14.                    | 11.                                | 14.                               | 12.            | 19.               | 14.          |
| Loss . . . . .           | 1.46           | —                   | 4.                      | —                          | 1.                     | 2.                                 | 3.                                | —              | 5.                | —            |

\* Hisinger.

† Henry.

‡ D'Aubuisson.

§ Ullmann.

|| D'Aubuisson.

\* \* Klaproth.



MARY.

Some of them are broken; and the colour is yellower, and lighter within.

MRS. L.

In the centre of the kidney-form masses (which vary from the size of a walnut to several inches in diameter) there is frequently a quantity of ochre; and they are always more compact at the surface than in the interior. The bog-iron ore is supposed to be constantly formed, by deposition from water containing oxyde of iron, in morassy grounds. According to its degree of hardness, it is called meadow ore, swamp ore, and morass ore.

FRANCES.

What is this piece; it is compact and shining in the middle, but on both surfaces it has the appearance of moss?

MRS. L.

That is meadow ore. It is generally almost black where it is compact, but yellow and brown on the dendritic parts. Sometimes the compact and ochry parts are in alternate plates, and very often these ores contain vegetable substances. The morass ore is quite friable and earthy.

MARY.

Is this another variety of it?

MRS. L.

No, that is umber; a hydrate of iron and man-

ganese: you know it is prepared for painting, both with oil and water.

FRANCES.

Yes; is it found in England?

MRS. L.

No; it is brought from the island of Cyprus. The next are the salts of iron, which are rather numerous.

MARY.

These specimens are not so beautiful as the salts of copper.

MRS. L.

There are few minerals which present such a variety of brilliant colours as the copper ores. The colours produced by iron, and which are characteristic of its ores, are generally dark or dull; prussian blue, however, is a preparation of iron; but it does not occur in a natural state. The carbonate of iron is mostly of a light yellowish-brown, sometimes dark and reddish, and very much resembles carbonate of lime: the angles of their primitive forms, which are both obtuse rhombs, differ only in a few degrees\*. This is from Cornwall.

FRANCES.

I suppose it will effervesce too?

MRS. L.

Yes; but its specific gravity, which is about 3.6, is sufficient to distinguish it from carbonate of lime; and before the blowpipe it becomes black. There

\* The angles of incidence of the planes are 107 and 73.

is still another method of determining whether a specimen be a carbonate of lime or of iron.

MARY.

What is that?

MRS. L.

I am going to show you. I have put a very small quantity into this wine-glass, and I add to it nitric acid. You see it is rapidly dissolving with effervescence; but as this effect would take place with any other carbonate in the same situation, I shall add a little prussiate of potash as soon as the effervescence has ceased. Look!

FRANCES.

The liquid has become bright blue.

MARY.

And the colour is deepening. What is the reason of it?

MRS. L.

The prussic acid, which was combined with the potash, unites to the iron, and forms prussiate of iron, or prussian blue.

FRANCES.

That is a very pretty experiment; I think when I am uncertain about a carbonate of iron, I will try it.

MRS. L.

The variety in hexagonal prisms was discovered not long ago in Cornwall: a more common form is the equiaxe rhomb. It is harder than carbonate of lime.

MARY.

The prisms have very much the colour and lustre of wax. And some of this is like pearlspar.

MRS. L.

Yes; but it is rarely so white as pearlspar. I have also a fibrous variety very like satinspar, but brownish-yellow. Botryoidal carbonate of iron, of a compact texture and nearly opaque, has been called sphaerosiderite. Clay-iron ore is an intimate mixture of carbonate of iron with silica and alumina. It varies considerably in its appearance. A good deal of it resembles claystone; and sometimes it has the form of shells and reeds.

FRANCES.

Is it fit to obtain iron from?

MRS. L.

It is not a rich ore; but it is occasionally mixed with the red ironstone, which is very rich: it then acts in some degree the part of a flux.

MARY.

Is this crimson mineral, clay-ironstone?

MRS. L.

Yes; that is the jaspery kind; it contains more silica, and is harder and more shining than the others. The phosphate of iron is blue. Those crystals are from Cornwall. (fig. 308.)

FRANCES.

How very transparent they are!

MRS. L.

There is sometimes a slight degree of pearlyness in them: the primitive form, deduced from its cleavage, is an oblique parallelopiped, very nearly like that of euclase. It may be cleaved readily in one direction, parallel to the axis.

MARY.

And is this phosphate of iron? It looks like the compact blue copper ore.

MRS. L.

Yes, that is the earthy phosphate; the composition is the same as that of the crystals, but it looks almost like a lump of indigo. It acquires that deep colour by exposure to the air: when it is first taken from the beds in which it occurs, it is greyish-white.

FRANCES.

Is it found in England?

MRS. L.

Yes; it was discovered some years ago in the Isle of Dogs, when excavations were being made for the docks; in a similar situation at Toxteth near Liverpool; and in the Shetland Isles; but not, I believe, in considerable quantity. Both the crystallized and earthy varieties are found in New Jersey: but I have never seen any crystals so fine as those from St. Agnes in Cornwall.

MARY.

And what are these small green cubic crystals?

MRS. L.

They are arseniate of iron.

FRANCES.

Some of them appear to be modified by small planes.

MARY.

Yes, and like the borate of magnesia, only the alternate angles are truncated. (figs. 309, 310, 311.)

MRS. L.

That circumstance suggested to me that it might possess the property of becoming electric by heat, and some time ago I tried the experiment.

FRANCES.

And was it electric?

MRS. L.

Yes, rather strongly. Some of the brightest and largest crystals are very translucent, but they are not common; indeed it is rather a scarce substance. It has been found in the Cornish mines Carrarach, Muttrell, and some others; and at St Leonard, in the department of Haute Vienne, in France: the specific gravity is 3. Pitchy iron ore, a combination of arseniate and sulphate of iron, which is found in Saxony, is very scarce; it is semi-transparent, of a brown colour, and occurs incrusting other minerals; it is very brittle, and soft.



FRANCES.

Is this it?

MRS. L.

No: that is chromate of iron. It is quite opaque, and has a more metallic lustre than most of the salts of iron: it is sufficiently hard to scratch glass, and is sometimes crystallized in the form of octahedrons.

MARY.

I think, without having recourse to the polar magnet, I might mistake it for magnetic iron ore.

MRS. L.

You may distinguish it by melting a little with potash, and dissolving it in water: the solution will have a beautiful orange colour. There are three substances at present known, which may be arranged under the next species, silicate of iron,—the first is a silicate containing water, named from Hedenberg, who first analysed it, hedenbergite. Yenite, or lievrite, is better known; it is a silicate of iron and lime, which is found in the Isle of Elba.

FRANCES.

This appears to be a very fine specimen, the crystals are so perfect. (fig. 312.) Is the substance from which they radiate also yenite?

MRS. L.

Yes, it is compact yenite. Four sides of the prisms are longitudinally streaked, and where there are more than these, the additional ones are smooth. It is

said that the colour sometimes becomes lighter and brownish by exposure to the air, and that when first procured it is always black.

MARY.

Are these silicates very hard?

MRS. L.

No ; the yenite will scratch glass, but not felspar. Pyrosmalite\*, a silicate of iron and manganese, occurs in short hexagonal prisms of a liver-brown colour, which when heated by the blowpipe emit a strong smell of chlorine.

FRANCES.

What does it smell like?

MRS. L.

It resembles sea-weed. Tungstate of iron is more abundant than either of these. It is well marked by its very dark-brown colour, and the brilliance and decision of its cleavages.

FRANCES.

They are very distinct ; but I see no appearance of external crystallization.

MRS. L.

Crystals of wolfram (as it is sometimes called) are scarce. They are parallelipipeds, occasionally modified on the edges and angles. (fig. 313.) It is generally in masses, or penetrating quartz and

\* or Pyrodmalite.

copper ore; it occurs in most tin mines. There is a great deal in the neighbourhood of the abandoned mines at Cligga in Cornwall, but it is of no use. It has a very peculiar glisten, which I think you will not forget; and it has a great deal of resemblance to brown bleade, but its specific gravity is much higher, being rather above seven, and the streak of a reddish colour. I am sorry I cannot show you a good specimen of the sulphate of iron, but it is found only in small quantities among pyrites; all that is used in commerce is prepared artificially.

MARY.

How is that done?

MRS. L.

The pyrites, from which it is obtained, is first exposed to heat for some time, which is called roasting it, and then laid in large heaps under sheds. These heaps are frequently moistened, and the sulphur, uniting with the oxygen of the water and the air, becomes sulphuric acid, and dissolves the iron. The liquid is suffered to run into large reservoirs, and is afterwards boiled. The natural sulphate arises from a decomposition of the pyrites amongst which it is found.

FRANCES.

Is not pyrites worked as an iron ore?

MRS. L.

No; but at Anglesea there is a manufactory for sulphur, which is prepared from it. The pyrites,

|                           | *<br>Carbonate<br>of<br>iron. | †<br>Clay<br>iron-<br>stone. | §<br>Phos-<br>phate of iron. | <br>Arse-<br>niate of<br>iron. | †<br>Sulph.<br>arseni-<br>ate. | <br>Chro-<br>mate. | **<br>Hy-<br>drous<br>silicate. | ††<br>Yenite. | ††<br>Pyros-<br>malite. | <br>Tung-<br>state. |
|---------------------------|-------------------------------|------------------------------|------------------------------|--------------------------------|--------------------------------|--------------------|---------------------------------|---------------|-------------------------|---------------------|
| Oxyde of iron . . .       | 42.38                         | 33.5                         | 41.25                        | 48.                            | 33.46                          | 34.7               | 35.25                           | 55.           | 35.480                  | 18.                 |
| Oxyde of manganese . . .  | —                             | 1.5                          | —                            | —                              | 0.59                           | —                  | 0.75                            | 3.            | 23.444                  | 6.25                |
| Oxyde of chromium . . .   | —                             | —                            | —                            | —                              | —                              | 43.                | —                               | —             | —                       | —                   |
| Silica . . . . .          | 0.8                           | 14.3                         | 1.25                         | —                              | —                              | 2.                 | 40.62                           | 28.           | 35.850                  | 1.5                 |
| Alumina . . . . .         | —                             | 22.6                         | 5.                           | —                              | —                              | 20.3               | 0.37                            | 0.6           | —                       | —                   |
| Lime . . . . .            | —                             | —                            | —                            | 2.                             | —                              | —                  | 3.37                            | 12.           | 1.210                   | —                   |
| Magnesia . . . . .        | 13.6                          | —                            | —                            | —                              | —                              | —                  | —                               | —             | —                       | —                   |
| Carbonic acid . . . . .   | 43.22                         | 28.1                         | —                            | —                              | —                              | —                  | 1.56                            | —             | —                       | —                   |
| Phosphoric acid . . . . . | —                             | —                            | 19.25                        | —                              | —                              | —                  | —                               | —             | —                       | —                   |
| Arsenic acid . . . . .    | —                             | —                            | —                            | 18.                            | 26.06                          | —                  | —                               | —             | —                       | —                   |
| Sulphuric acid . . . . .  | —                             | —                            | —                            | —                              | 10.75                          | —                  | —                               | —             | —                       | —                   |
| Muriatic acid . . . . .   | —                             | —                            | —                            | —                              | —                              | —                  | —                               | —             | 2.905                   | —                   |
| Tungstic acid . . . . .   | —                             | —                            | —                            | —                              | —                              | —                  | —                               | —             | —                       | 67.                 |
| Water . . . . .           | —                             | —                            | 31.25                        | 32.                            | 28.48                          | —                  | 16.05                           | —             | —                       | —                   |

\* Drappier.  
|| Vauquelin.

† Klaproth.  
\*\* Hedenberg.

† Richter.  
†† Descotils.

†† Hisinger.

§ Laugier.

when broken up, is roasted. This occasions the sulphur to separate in the form of vapour; and it is collected in long flues, where it is condensed and becomes solid. The residue is of a fine deep-red colour, and is used at Liverpool for painting ships. I believe you know that sulphate of iron is used in making ink?

FRANCES.

Yes; I have heard it called green vitriol.

MARY.

Are there any more minerals belonging to this genus?

MRS. L.

No: the next are the ores of manganese, which generally contain some proportion of iron; and you will find (by the tables of analyses) that oxyde of manganese occurs in many iron ores.

## CONVERSATION XVI.

---

MRS. L.

MANGANESE has never been found in a pure state: all these specimens are varieties of the oxyde; those in the next drawer are salts.

FRANCES.

I think I have seen some of these little dark shining crystals before.

MRS. L.

Yes; they are frequently found in tufts on quartz: but this substance occurs more abundantly in a fibrous and somewhat compact state. It then resembles brown hæmatite very strongly both in fracture and external form. It is often dendritic or stalactitic.

MARY.

How would you distinguish them?

MRS. L.

Oxyde of manganese is much softer than the hydrate of iron. But the most satisfactory method of examining it, is to melt a small portion with glass of borax; the manganese ore will give it a reddish-



purple tint, as in window-glass. Remember always to use a very small quantity for such experiments.

FRANCES.

The fibrous variety does not seem to have quite so much lustre as the brown hæmatite.

MARY.

Is the primitive form a prism ?

MRS. L.

Yes, a right rhombic prism (fig 314); which is usually so short as to resemble a cube at first sight.

FRANCES.

Some of these crystals appear to have six or eight sides.

MRS. L.

That is not uncommon. The prisms in the radiated specimens are generally modified, and are long in proportion to their thickness. (figs. 315, 316.) The primitive crystals are the most brilliant; but the others possess a strong metallic lustre.

MARY.

The compact kind appears the darkest-coloured.

MRS. L.

This has been mistaken for an iron ore, and called black hæmatite. You see there is a complete transition from the distinct prismatic crystals, through the radiated and fine fibrous to the com-

pact variety. The least common is the earthy grey oxyde: it has scarcely any lustre, and soils strongly.

MARY.

I see that, by the condition of my fingers after touching it; they are quite black.

MRS. L.

Most of the grey manganese ores will leave a trace on paper; the earthy is the darkest. The black oxyde has not, I believe, been analysed; it is much more rare than the grey ore, and is generally found with the grey ore of antimony. It is quite black, and sometimes friable, or dendritic: the only variety that has any lustre is the foliated.

FRANCES.

I suppose it will colour borax purple, like the other species?

MRS. L.

Yes; that is characteristic of all manganese ores. The species called wad appears, both from its composition and external characters, to be very little different from umber; but it contains more manganese than iron, and it frequently has a decided external form, which umber has not.

MARY.

Yes; these are botryoidal and reniform, and look as if they had been imbedded in something else.

MRS. L.

That kind occurs in basalt and hornstone. This

specimen, of nearly the same colour as the grey ore, is sulphuretted oxyde : when it is exposed to the action of the blowpipe, you may smell the sulphur which is disengaged ; it is found at Nagyag with the ores of tellurium.

FRANCES.

I think there is some tellurium here. But is it not found in great Britain ?

MRS. L.

Yes ; at Upton Pyne, in Devonshire, all these varieties are found, most of them abundantly : and some occur both in Ireland and Scotland.

MARY.

What is the specific gravity of these minerals ?

MRS. L.

The compact and radiated grey manganese have a specific gravity between 3.5 and 4.5 ; the sulphuretted oxyde is very nearly 4.

MARY.

Is this one of the acidiferous compounds of manganese ? it is like the oxyde.

MRS. L.

Yes ; that is the phosphate : you may easily distinguish it from the oxydes, by its being readily fusible by the blowpipe, without the addition of any flux, into a black enamel which has a metallic lustre and is very magnetic ; and in thin fragments it is semi-transparent.

|                     | * Radiated grey manganese ore | † Compact grey mangan. | † Sulphur-<br>retted<br>oxyde. | † Phosphate<br>of<br>mangan. | § Silicate<br>of<br>mangan. | * Pitch ore. | Uran-<br>mica. |
|---------------------|-------------------------------|------------------------|--------------------------------|------------------------------|-----------------------------|--------------|----------------|
| Oxide of manganese  | 92.75                         | 82.                    | 85.                            | 42.                          | 52.60                       | —            | —              |
| Oxide of iron . .   | 7.                            | —                      | —                              | 31.                          | 4.60                        | 2.5          | —              |
| Silica . . . .      | —                             | 7.                     | —                              | —                            | 39.60                       | 5.0          | —              |
| Lime . . . .        | —                             | 8.5                    | —                              | —                            | 1.50                        | —            | —              |
| Barytes . . . .     | —                             | 2.                     | —                              | —                            | —                           | —            | —              |
| Sulphur . . . .     | —                             | —                      | 15.                            | —                            | —                           | —            | —              |
| Phosphoric acid . . | —                             | —                      | —                              | 27.                          | —                           | —            | —              |
| Oxide of uranium .  | —                             | —                      | —                              | —                            | —                           | 86.5         | 74.4           |
| Oxide of copper . . | —                             | —                      | —                              | —                            | —                           | —            | 8.2            |
| Sulphuret of lead . | —                             | —                      | —                              | —                            | —                           | 6.           | —              |
| Water . . . .       | —                             | —                      | —                              | —                            | —                           | —            | 15.4           |
| Loss . . . .        | 0.25                          | 0.5                    | —                              | —                            | —                           | —            | 2.             |
|                     |                               |                        | Volatile matter.               |                              | 2.75                        |              |                |

\* Klaproth.

§ Berzelius.

† Cordier and Beaunier.

|| Gregor.

‡ Vauquelin.

The prettiest ore of manganese is the carbonate : it is of a rose-colour of various degrees of intensity.

FRANCES.

This is very beautiful ; and I think these dark veins running through it make the red colour appear more brilliant.

MRS. L.

They are veins of sulphuret of manganese and oxyde of iron. In general it is compact, but sometimes it has a threefold cleavage, which at first caused it to be considered as felspar coloured by manganese : this kind is in general paler than the compact variety.

MARY.

The compact kind, I think, is a good deal like hornstone, except that it is more translucent : is it hard ?

MRS. L.

No : it scratches glass with difficulty, and yields to the knife.

FRANCES.

Is it ever used for any thing ornamental ?

MRS. L.

I have seen snuff-boxes made of it ; but it is rather a scarce mineral.

The next specimen may be considered as a siliceous carbonate of manganese. The colour is paler than that of the carbonate, and is sometimes yellowish.

MARY.

And the fracture is more inclining to fibrous.

MRS. L.

It is also considerably harder than the foregoing species. This will give sparks with steel. It is called rhodonite, from its red colour. Allagite contains more carbonic acid, and is brown or green, with a flat conchoidal fracture. Photizite, a third variety, is described as being compact, and sufficiently hard to scratch felspar. It contains a still greater proportion of carbonic acid, and very much resembles rhodonite in appearance. The fourth kind, called hornmangan\*, when much heated becomes phosphorescent; and with borax, fuses into a hyacinth-red glass.

FRANCES.

Do these yellow crystals belong to any of the four carbonates?

MRS. L.

No: they have not been accurately analysed; but from the results obtained by the blowpipe, Berze-

|                  | Allagite. | Rhodon-<br>ite. | Photizite. | Hornman-<br>gan. |
|------------------|-----------|-----------------|------------|------------------|
| Ox. of manganese | 75.       | 49.87           | 46.13      | 54.587           |
| Silica . . . .   | 16.       | 39.             | 39.        | 34.              |
| Alumina . . .    | —         | .125            | .25        | —                |
| Oxyde of iron .  | —         | .25             | .50        | .5               |
| Carbonic acid .  | 7.50      | 4.              | 11.        | 8.               |
| Water. . . .     | —         | 6.              | 3.         | 2.               |

\* By Leonhard, who first described these varieties.



lius considers it to be a silicate of manganese. It is called helvine. The crystals are octahedrons; usually having four large and four smaller planes, which meet under the same angles as the faces of the regular octahedron.

MARY.

Are these ores found with the brown and grey ones, which you said were abundant in Devonshire?

MRS. L.

I am afraid, Mary, that you will be much disappointed in your travels through Devonshire and Cornwall, if you expect to find the greater part of the minerals in my collection. These carbonates and silicates of manganese are all foreign. The carbonate occurs at Kapnic in Bohemia; helvine, in the mine called Brothers Lorenz, near Schwartzenburg in Saxony; and the others in different parts of the Hartz.

The next three metals are scarce, and by no means extensive in their combinations.

FRANCES.

I see some beautiful green specimens, and apparently crystallized.

MRS. L.

They are phosphate of uranium, or uran-mica; but the first species is this black substance, known by the name of pitch-ore; it is an oxyde of uranium.

MARY.

It is not very much like pitch ; the lustre is so metallic, and the fracture so uneven.

FRANCES.

It is very heavy, notwithstanding the specimen contains a great deal of some earthy substance.

MRS. L.

The specific gravity is about six and a half, which is greater than that of most minerals that have nearly the same appearance. Perhaps the most satisfactory experiment to determine whether a specimen is pitch-ore, is to dissolve a small quantity in nitric acid ; the solution will have a pale orange-yellow colour ; and if you add any alkali to it, the uranium will be precipitated in the form of a yellow powder. The solution of the uran-mica is of a much brighter yellow : this circumstance will distinguish it from copper-mica, of which the solution is green.

MARY.

I think I should never have occasion to make that experiment, to know the uran-mica, the light green colour is so vivid and rich ; it is more beautiful than any I have seen.

MRS. L.

It is certainly a delightful colour ; but when you have seen some of the zinc and lead ores, you will not be inclined to depend so much on that character as on the crystallization.

FRANCES.

O no, that is certainly the most decisive. These crystals, I think, are all tabular. (figs. 317, 318, 319, 320.)

MRS. L.

Yes. The primitive form is a very low rectangular prism : sometimes these little tables or plates adhere to the surface of the ironstone, or quartz, or other minerals with which they occur. Here are some of a sulphur colour, and on this specimen they are confusedly aggregated together.

MARY.

Will it split, like mica ?

MRS. L.

It *can* be cleaved, but not with so much ease as mica, on account of its frangibility : the only distinct cleavage is that parallel to the base.

Phosphoric acid has not long been known as a constituent of uran-mica. It was discovered by Mr. Richard Phillips, who analysed some from Gunnis Lake in Cornwall. It contains also a portion of phosphate of copper, to which he attributes its colour\*. The uran-ochre is another oxyde : it contains more oxygen than the pitch-ore. In general it occurs as a powder of different tints of

\* The yellow variety from Autun, in the south of France, Berzelius describes as a double subphosphate of lime and the yellow oxyde of uranium.

yellow and orange, coating the pitch-ore. Sometimes it is indurated and massive.

MARY.

Are the oxydes also found in England?

MRS. L.

Yes: they are all met with in many of the Cornish mines\*; and it is found in Saxony, and at Limoges in France. The ores of cerium are silicates and fluates. They are all dark-coloured, and only one species has been observed crystallized—the pure fluat, which is found at Finbo in Sweden. The crystals are hexagonal prisms.

MARY.

What kind is this grey ore, with a fine splintery fracture?

MRS. L.

It is cerite, a silicate: the colour generally has a crimson tinge, with scarcely any lustre. If you scratch it, the streak is greyish-white. Allanite contains 25 per cent of iron, and is brownish and shining. Gadolinite contains also 45 per cent of yttria, and is quite black, except in small splinters, which appear greenish when held between the eye and a strong light.

FRANCES.

If it were not so heavy, it might be taken for a piece of coal fresh broken: the lustre is so shining.

\* Particularly Carharak, Tincroft, Tolcarn, and at Gunnis Lake near Callington.

MRS. L.

The specific gravity is about 4; that of cerite 4.6. All these species will scratch glass, and give sparks with steel: gadolinite is even as hard as quartz.

MARY.

Pray, is gadolinite an English name?

MRS. L.

No; the mineral was named at Ytterby in Sweden, (where it was discovered,) from Professor Gadolin, who first ascertained its composition. Like some of the earthy minerals, it gelatinizes with hot diluted nitric acid; and with borax, melts into a topaz-coloured glass.

FRANCES.

What is this violet-coloured mineral imbedded in quartz?

MRS. L.

It is yttrocerite; a compound of three fluates,—of lime, yttria, and cerium.\* It is sometimes in thin crusts, sometimes in lumps; and the colour occasionally reddish and light grey. It has been found only at Finbo, where most of the other species occur. Orthite is a good deal like gadolinite; but instead of occurring in small irregular masses, it

\* *Yttrocerite*.

|                        |       |
|------------------------|-------|
| Fluate of lime . . . . | 68.18 |
| ———— yttria . . . .    | 10.60 |
| ———— cerium . . . .    | 21.22 |

forms thin straight veins in felspar and granite. It contains, besides the oxyde of cerium, those of iron and manganese, and silica, lime, alumina, and yttria. The variety called pyrorthite contains 25 per cent of charcoal, and takes fire before the blowpipe. There is also a subfluat of cerium, of a yellow colour. But all these ores are very unimportant, as well as those of tantalum, which are both oxydes.

MARY.

Do they crystallize?

MRS. L.

Yes, in oblique rhomboidal prisms; but both the crystals and irregular pieces are extremely rare, having been found in very small quantity in Finland, and more lately at Bodenmais in Bavaria: it is always nearly black, and internally shining, with an indistinct cleavage.

|                     | Cerite. | Allanite. | Gadolinite. | Orthite. |
|---------------------|---------|-----------|-------------|----------|
| Oxyde of cerium . . | 68.59   | 33.9      | 16.69       | 19.50    |
| — iron . .          | 2.      | 25.4      | 10.26       | 12.44    |
| — manganese         | —       | —         | —           | 3.44     |
| Silica . . . . .    | 18.     | 35.4      | 25.80       | 32.      |
| Alumina . . . . .   | —       | 4.1       | —           | 14.80    |
| Yttria . . . . .    | —       | —         | 45.         | 3.44     |
| Lime . . . . .      | 1.25    | 9.2       | —           | 7.84     |
| Water . . . . .     | 9.60*   | 4.        | —           | 5.36     |
| Volatile matter . . | —       | —         | 0.60        | —        |
| Loss . . . . .      | 0.56    | —         | 1.65        | —        |

\* Including some carbonic acid.



FRANCES.

It is very much like some of the ores of cerium.

MRS. L.

Yes; but its high specific gravity is sufficient to distinguish it: it varies from 7.1 to 7.9. The yttrotantalite very much resembles it; but it has a distinct cleavage, and the specific gravity is between 5.3 and 5.9: it is about as hard as felspar. There is more variety in the ores of cobalt; but some of them, the alloys and sulphuret, are so much alike, that you must have a good deal of experience in examining minerals, before you will find it easy to distinguish them from each other and from some other minerals. The alloys contain more arsenic than cobalt.

MARY.

Then, I suppose, the blowpipe would have nearly the same effect on them all?

MRS. L.

Yes, they all emit alliaceous fumes, and tinge borax blue. But there is a difference in the external characters of the three species. The tin-white cobalt crystallizes in cubes, either perfect or truncated on the angles, or in octahedrons.—This is a very fine specimen, from Saxony.

FRANCES.

But all the cubes are cracked in various directions.

MRS. L.

That is their natural and most usual appearance; it is much more commonly found disseminated through mica-slate, in small foliated grains, very shining, and of a reddish-white colour. All the alloys have a strong metallic lustre.

MARY.

What is this compact grey specimen?

MRS. L.

It is called grey cobalt ore, and is never crystallized, but massive, or disseminated through quartz. The most brilliant of this family is the cobalt-glance\*. You will have no difficulty, I think, in understanding these crystals.

FRANCES.

They are uncommonly perfect and brilliant.

MARY.

They seem to be the same as those of iron pyrites.

MRS. L.

Yes, they are: those are from Modum in Norway, imbedded in copper pyrites; the other two alloys are found occasionally in Cornwall, but seldom well crystallized. The sulphuret of cobalt, or cobalt pyrites, is rarely crystallized, and very much like the grey ore; but the sulphureous vapour which arises from it on the application of heat,

\* Silver-white cobalt ore.

distinguishes it. The oxydes of cobalt are always more or less earthy, and have therefore been called black, brown, and yellow cobalt ochre. The black oxyde is sometimes considerably indurated.

FRANCES.

I should think, as all these appear to be a good deal intermixed with other substances, particularly this dingy-yellow oxyde \*, that the best, or at least the shortest way to examine them, would be with the blowpipe.

MRS. L.

Certainly, the result is very satisfactory; they all give a blue tint to the flux employed with them. They generally form a thin crust on other ores. The arseniate sometimes occurs in the same situation; it is called cobalt bloom.

MARY.

Is it this rose-coloured glimmering mineral?

MRS. L.

Yes, that is the earthy arseniate, as well as the very small botryoidal concretions in the cavities of this grey cobalt.

FRANCES.

And are these dark-brownish crimson specimens the same substance in a radiated form?

\* At Schemnitz in Hungary, and Allemont in France, the miners find a mixture of cobalt ochre, arseniate of cobalt, and nickel ochre, with native silver, which they call goose-dung ore. It is partially covered by a greenish-yellow pulverulent crust.

|                           | *<br>White cobalt<br>ore. | *<br>Grey cobalt<br>ore. | †<br>Cobalt glance. | §<br>Cobalt<br>pyrites. | <br>Arsenate of<br>cobalt. | **<br>Sulphate of<br>cobalt. |
|---------------------------|---------------------------|--------------------------|---------------------|-------------------------|----------------------------|------------------------------|
| Cobalt . . . . .          | 9.6                       | 12.7                     | 36.7                | 43.2                    | —                          | —                            |
| Oxyde of cobalt . . . . . | —                         | —                        | —                   | —                       | 39.2                       | 38.71                        |
| Arsenic . . . . .         | 68.5                      | 50.                      | 49.0                | —                       | —                          | —                            |
| Iron . . . . .            | 9.7                       | 12.5                     | 5.6                 | 3.53                    | —                          | —                            |
| Copper . . . . .          | —                         | —                        | —                   | 14.4                    | —                          | —                            |
| Sulphur . . . . .         | 7.0                       | —                        | 6.5                 | 38.50                   | —                          | —                            |
| Silica . . . . .          | 1.0                       | 25.0                     | —                   | —                       | —                          | —                            |
| Water . . . . .           | —                         | —                        | —                   | —                       | 22.9                       | 41.55                        |
| Arsenic acid . . . . .    | —                         | —                        | —                   | —                       | 37.9                       | —                            |
| Sulphuric acid . . . . .  | —                         | —                        | —                   | —                       | —                          | 19.74                        |
| Stony matter . . . . .    | —                         | —                        | —                   | .33                     | —                          | —                            |
| Loss . . . . .            | 4.2                       | —                        | 2.2                 | .04                     | —                          | —                            |
| * Laugier.                | † Tassaert.               | ‡ Klaproth.              | § Hisinger.         | Bucholz.                | ** Kopp.                   |                              |

MRS. L.

Yes: they are composed of delicate acicular crystals, seldom large enough to have their form determined; but they appear to be four- or six-sided prisms obliquely terminated by two planes. It has been found in Scotland and Cornwall, as well as at several places in Saxony, Hungary, Salzburg, and Norway. The sulphate of cobalt is a soluble salt, of an earthy texture; it is generally in a stalactitic form, which consists of distinct granular concretions: this is from the Hartz.

MARY.

It is very much like the arseniate, except being opake.

MRS. L.

It is only the crystallized arseniate that is translucent, or semi-transparent; but you will know the sulphate by its solubility. I am afraid I have shown you so many different ores, that you will have but a confused notion of them. However, there are some properties peculiar to each species, which if you recollect, they will materially assist you in distinguishing them: for instance, a blue colour may be produced by any of the cobalt ores. The ores of cerium and tantalum are mostly characterized by their dark colours and high specific gravity. Of the combinations of uranium, only the pitch-ore is very heavy; but their colour, crystallization, and

yellow solutions in nitric acid, will at once tell you that they can be compounds of no other metal.

MARY.

I think I shall recollect these characters, because they seem to apply to the whole genus; but I assure you it will be long before I venture to give a name to a specimen.

FRANCES.

But we had better always examine it in all possible ways before we ask its name.—What is the next metal in your arrangement?

MRS. L.

Nickel. It is found native, alloyed, and mineralized by oxygen and arsenic acid: its ores are found in veins, in small quantity, and usually with those of cobalt.

MARY.

Is this native nickel, or an alloy?

MRS. L.

It is nearly pure nickel. Originally it is of a pale reddish-bronze colour, but after being exposed for some time to the air it acquires a grey tarnish: it occurs always in capillary crystals.

FRANCES.

I think you said that nickel was magnetic?

MRS. L.

When purified, it is; but this will not affect the



magnet till it has been fused, or at least exposed to the blowpipe. On charcoal, it may be fused sufficiently to agglutinate the fibres. The ore called copper nickel contains nearly 50 per cent of arsenic, and small quantities of other metals; it is nearly the colour of native copper, and always amorphous.

FRANCES.

Will the blowpipe reduce it?

MRS. L.

Yes, but the globule soon darkens by exposure to the air; a knife scratches it with some difficulty, and it is rather frangible: the specific gravity is about 7.5. Another alloy of nickel, called glance nickel, has lately been discovered, nearly white and having a foliated fracture; it appears to be a combination of iron pyrites and arseniuret of nickel.

MARY.

If I were to find it, how should I know it?

MRS. L.

Perhaps there would be some difficulty in it; but you would find, after examining it, that it has not the same properties as other minerals that resemble it in some respects, and of which you know the names. But I am by no means sure that you will know any of these nickel ores the next time you see them; it is more difficult than you imagine, to determine their composition. In short, unless you know enough of chemistry to analyse your spe-

cimens, you must be content to trust to other persons in a great degree for information concerning them. But whenever you have the opportunity of seeing well marked and fine specimens of any substance, examine them well, that you may be able to know a similar one when it comes in your way.

MARY.

I shall always endeavour to recollect your advice when I see any minerals.

FRANCES.

And above all things I shall look at the crystals.

MRS. L.

You will see a great variety presently in the tin ore. But you have not seen all the nickels. These light-green earthy minerals, though very much alike, are two distinct species : this, which generally forms a thin earthy crust, is oxyde of nickel, or nickel ochre ; the most massive specimens are arseniate of nickel. Some are very pale, or greenish-white.

MARY.

I really see no difference between them, except in their colour, and that does not seem to be essential.

MRS. L.

The blowpipe, by decomposing the arseniate of nickel, will show you to which family it belongs, as you will smell the arsenic. The oxyde passes into pimelite ; and if melted with borax produces

a glass of a hyacinth-red colour. The arsenical nickel occurs in some of the Cornish mines; and filaments of native nickel have been met with in its cavities.

The only ores of molybdenum at present known are the sulphuret, which is found massive of a blackish grey colour, and the ochre, which has not been correctly analysed.

FRANCES.

It appears to have a micaceous structure.

MRS. L.

Yes, the cleavage is parallel to the base of a rhomboidal prism, which is considered as its primitive form. Sometimes it crystallizes in hexagonal plates. It is more like talc than mica, being flexible, but not elastic.

MARY.

I think it is not exactly like any thing else I have seen; I should not mistake it for micaceous iron ore, because this is quite opaque.

MRS. I.

Perhaps the most distinctive character is, that it will write on paper, but less strongly than plumbago or black lead; still there is so much similarity between them, that they were formerly confounded together: it is very soft, and feels greasy. In warm nitric acid it effervesces, but does not entirely dissolve; and the specific gravity is between 4.5 and 4.8.

FRANCES.

Is it found in England?

MRS. L.

Very sparingly, in the granite of Cornwall, and in Cumberland; it is rather more abundant in Norway and the United States.

There are only three ores of tin; and of these only one (which is nearly a pure oxyde) is smelted.

MARY.

I suppose it is abundant, as there are so many tin-mines in Cornwall?

MRS. L.

Yes, it is plentiful in most of the places where it is found; but there are not many districts where tin occurs. There are three in Europe: one is between Saxony and Bohemia, in the range of mountains called the Erzgebirge; another in Galicia, on the borders of Portugal; and the third is in Cornwall. It abounds in Siam and the island of Banka; and it has been discovered in Chili and North America. I believe the Cornish mines have been worked longer than any others, for it was from them that the Phœnicians procured the tin which they used in making their armour: they alloyed it with copper.

FRANCES.

I suppose tin would be too soft by itself?

MRS. L.

Yes, the mixture of the two metals is much harder than either of them separately: bell-metal is an alloy of this kind. This mineral has been called bell-metal ore.

MARY.

Is bell-metal obtained from it?

MRS. L.

No: it has been found only at three or four places in Cornwall, and in small quantity. The yellowish tinge on it is not a tarnish; the colour is between that of brass and steel.

FRANCES.

It is like iron pyrites, except in being greyer.

MRS. L.

It is something like it in fracture too; in one direction foliated, in the others small conchoidal. It is called tin pyrites also, and is generally intermixed with copper ores. In most of the Cornish mines, both copper and tin are raised. It is rather curious that the specific gravity of tin is not quite

*Analysis of Tin Pyrites, by Klaproth.*

| Tin. | Copper. | Iron. | Sulphur. | Loss. |
|------|---------|-------|----------|-------|
| 26.5 | 30.     | 12.   | 30.5     | 1.    |

7.3, and the oxyde has a specific gravity between 6.8 and 7.0; while among the ores of copper and iron, scarcely any have a specific gravity above 5.

MARY.

I was surprised on taking this up to find it so heavy. How brilliant these dark crystals are!

MRS. L.

They are oxyde of tin, or tinstone. Brownish-black is their most common colour, but I have some nearly colourless, and quite transparent.

FRANCES.

Some of these bright-brown crystals are nearly transparent, but the large black and reddish ones are opaque.

MARY.

They all seem to be square prisms terminated by pyramids. What is the primitive form?

MRS. L.

It is a flat octahedron with a square base (fig. 321), but it is never found without a prism intervening between the two pyramids. These (figs. 322, 325) are the commonest of its crystallizations, except the macles, some of which are abundant, particularly this. (fig. 332.)

FRANCES.

Most of these are so much imbedded in the quartz and mica, that I can see only half, or a small part of them.



MRS. L.

You will see quartz and mica with most of them ; and in some specimens a variety of other minerals. Here is one where I think you will know them all.

FRANCES.

Here are quartz and mica again ; and I think these cubes are fluor:—and here is pyrites, but I do not know which kind.

MRS. L.

Try if you can find out, Mary.

MARY.

I see no foliated fracture ; and where there is some indication of a regular form, the angles are certainly not those of a cube or dodecahedron : it must be copper pyrites.

MRS. L.

You are right.

FRANCES.

I cannot remember what these pale lilac crystals are ; they are not crystallized like fluor.

MRS. L.

They are very imperfect, or I think you would have known them to be phosphate of lime. Sometimes tinstone is found with topazes and chlorite, but seldom with lead or silver ores. The acute pyramidal crystals are much less common than the others :—these are from Bohemia. (figs. 328, 330.) Mr. Phillips, who has spent a great deal of time in

examining the different crystallizations of tinstone, and has sacrificed many crystals to ascertain their cleavage, has enumerated twelve modifications \*, which, by different combinations with the primitive, presented about two hundred varieties of form. The cleavages are parallel to the sides and the diagonals of the prism, and to the faces of the octahedron.

FRANCES.

That is a greater number than you find in most minerals, I should think ?

MRS. L.

Yes, few have so many. You may remark, that though the crystals of tinstone have a splendid lustre, the fracture is almost dull ; and when you scratch it, the streak is greyish-white :—Look.

MARY.

It is indeed, and the powder is of the same colour.

MRS. L.

Sometimes the crystals are extremely small, and quite intermixed with mica ; and it is found amorphous, with a somewhat granular structure : it has then the appearance of pebbles, from the size of a large onion to that of sand. These deposits usually occur in low marshy ground, and sometimes grains of native gold are found with them. It is called stream-tin, because, when it is worked, the earthy

\* See Transactions of the Geological Society, vol. ii.

matter with which it is intermixed, is separated by passing streams of water over it. At Finbo in Sweden there has been discovered an oxyde of tin, containing from two and a half to twelve per cent of oxyde of columbium; it is said to occur in small octahedrons and grains, imbedded in granite.

MARY.

Are these some of them? they are marked with light coloured spots and rings.

MRS. L.

No, they are another subspecies, called wood-tin; it has been observed only in Mexico and Cornwall: the structure is diverging fibrous, and in general very compact. It has a great deal of similarity to hæmatite, and was at one time confounded with it.

FRANCES.

It has very little lustre. Is it the same substance as the crystallized oxyde?

MRS. L.

Yes; it differs only in form and texture\*. It is always found in rolled pieces, which are seldom

\*

|                      | * † ‡<br>Tinstone.  |     |      | §<br>Wood-<br>tin. |
|----------------------|---------------------|-----|------|--------------------|
| Oxyde of tin . . . . | 99.5                | 95. | 93.6 | 91.                |
| — tantalum . . . .   | —                   | —   | 2.4  | —                  |
| — iron . . . .       | 0.5                 | 5.  | 1.4  | 9.                 |
| — manganese . . . .  | —                   | —   | 0.8  | —                  |
| Loss . . . .         | —                   | —   | 1.8  | —                  |
| * Klaproth.          | † Collet-Descotils. |     |      |                    |
| ‡ Berzelius.         | § Vauquelin.        |     |      |                    |

larger than a cherry; but Mr. Mawe has a piece from Mexico which weighs ten ounces and a half: the specific gravity is about 6.4.

MARY.

Will the blowpipe reduce it to a metallic state?

MRS. L.

Only in part, when it is placed on charcoal. The process of smelting tin is very tedious, and consists of many operations.

Here is still another specimen for you to examine.

FRANCES.

Oh, Mrs. L., another green mineral!

MRS. L.

You see how fallacious a character is colour *alone* to distinguish many substances. This is oxyde of chrome.

MARY.

It is certainly very like the green ores of nickel.

MRS. L.

The colour of this ore is generally deeper; and it is disseminated in masses, while the nickel ochre forms only a pulverulent crust. But when you are in any doubt, have recourse to your blowpipe. Chrome always communicates a beautiful green tinge to the flux used with it: nickel gives it a hyacinth-red colour. If you are fond of this test, you should read the essay of Berzelius on the blowpipe, translated by Mr. Children.

## CONVERSATION XVII.

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MRS. L.

I ADVISE you to pay attention to the *external* characters of the minerals in this family; for the *chemical* ones you would not find it easy to examine, nor perhaps very satisfactory, till you know a great deal more of chemistry; it is so extremely difficult to reduce them to a metallic state. The pure oxydes of titanium, I think, you will easily recollect when you see them again. The rutile is generally of a red colour, and sometimes crystallized, sometimes radiated or fibrous.

FRANCES.

That is a very beautiful colour.

MARY.

I think it is what you call hyacinth-red?

MRS. L.

Yes, it is: this is cherry-red. I have also a variety extremely like gold; it occurs in small patches, which consist of delicate fibres intersecting each other.

FRANCES.

I think it would not be very surprising if I mistook it for gold.

MRS. L.

This is slightly translucent ; but if you cannot perceive that, heat it with the blowpipe, and it will become brown and opaque\*. The red fibrous specimens are very much like red schorl, and before the metal titanium was known, were arranged with it, though the specific gravity is about 4.2. This is not so surprising, however, as it may appear ; for when mineralogy was little understood, and crystallography still less, an immense variety of substances were classed together ; and if they were crystallized (particularly in a prismatic form), they were generally called schorl†. The crystals are six- or eight-sided prisms, and, occasionally, two are jointed together. (fig. 334.)

MARY.

That is a very singular twin crystal.

FRANCES.

Is rutile found in England ?

MRS. L.

I believe not : it has been met with in the quartz of Cairn Gorm ; and is not unfrequent in the quartz of various parts of Europe, particularly Switzerland, the Tyrol, and Hungary.

\* It is suspected that this may prove to be pure metallic titanium.

† See Ferber's Travels, where almost every crystallized mineral is denominated schorl.



MARY.

Here are some beautiful dark crystals, partly imbedded in rock crystal—rutile, I suppose.

MRS. L.

That has lately been discovered to differ from rutile, both in its secondary and primitive forms; but I believe it is still considered to be an ore of titanium. The crystals are complicated. Mr. Lévy has given it the name of Brookeite.

It was discovered about thirteen years ago on Snowdon, in very complicated crystals, which were figured by Mr. Sowerby in his *British Mineralogy*. When the rutile is in delicate parallel fibres, inclosed in rock-crystal, it is sometimes cut into ornaments, and called Venus's hair. The anatase, or octahedrite, is apparently a very different substance. Here are some crystals from Dauphiné. (figs. 335, 336, 337.)

MARY.

They seem to be long octahedrons.

MRS. L.

Yes, the base of the pyramids is square. This is another example of what I just now said to you: octahedrite was once named blue schorl. The crystals are small, but in general very perfect, shining, and not imbedded in the substances with which they occur; but appear resting on them.

FRANCES.

I think these are sprinkled over crystallized quartz and adularia.

MRS. L.

It is usually accompanied by those minerals, and frequently by chlorite and axinite.

MARY.

And what is the difference between this mineral and rutile?

MRS. L.

The only chemical difference is, that it contains a little more oxygen. There are three other oxydes, all containing iron, which are found only in the state of sand. Iserine and menachanite differ so little in composition and appearance, that I think they may be considered as varieties of the same species: they both attract the magnet, but so slightly, that you would not mistake them for iron-sand.

FRANCES.

And that is the only mineral I have seen that I *could* mistake them for.

MRS. L.

Nigrine occurs in rather larger grains, and is not attracted by the magnet at all; probably because the proportion of oxyde of iron is less than in the other two species. The family of salts contains two minerals: crichtonite, which is considered to be a silicate; and sphene, which is a silicate of

titanium and lime. The crichtonite occurs in very small black shining crystals with anatase.

MARY.

Are there any on this specimen?

MRS. L.

Yes. You would not perhaps know them at first, being so nearly of the same size and colour with the anatase: but their form is a very acute rhomb¶, having the summits deeply truncated.

FRANCES.

Are these detached crystals, sphene?

MRS. L.

Yes, those are twin crystals; but the most perfect I have, are dispersed over that specimen of adularia and chlorite.

|   | *            † |       | ‡        | §        |
|---|----------------|-------|----------|----------|
|   | Menachanite.   |       | Iserine. | Nigrine. |
| Oxyde of titanium . .                     | 43.5           | 45.25 | 41.1     | 63.      |
| — iron . . .                              | 50.4           | 51.   | 39.4     | 35.      |
| — manganese .                             | 0.9            | 0.25  | —        | 2.       |
| — uranium .                               | —              | —     | 3.4      | —        |
| Silica . . . . .                          | 3.3            | —     | 16.8     | —        |
| Alumina . . . . .                         | 1.4            | —     | 3.2      | —        |
| Loss . . . . .                            | 0.5            | —     | —        | —        |
| * Lampadius.    † Klaproth.    ‡ Thomson. |                |       |          |          |
| § Vauquelin and Hecht                     |                |       |          |          |

¶ This rhomb is very similar to that of carbonate of lime.  
(fig. 201.)

MARY.

That is a beautiful specimen indeed, every part of it seems so perfectly crystallized,—the quartz, the adularia, the chlorite, and the sphene; but the crystals are complicated.

MRS. L.

Here are some models of them, which will perhaps be more intelligible to you. (fig. 339.) The primitive form is an oblique rhombic prism, but it does not occur unmodified. Those brownish-red ones (fig. 340) resemble grenatite a little, being opaque.

FRANCES.

The transparent ones are extremely pretty, one end is greenish-yellow, and the other a bright hyacinth-red.

MRS. L.

Those are from Salzburg; and the pale green ones, which contain chlorite disseminated through them, are from the mountain St. Gothard. Very fine ones, nearly two inches in length, have lately been brought from the Grisons; they have generally a splendid lustre, unless they are incrustated with chlorite\*.

\*

|                             | * Sphene.    | †   |
|-----------------------------|--------------|-----|
| Oxyde of titanium . . . . . | 33.          | 58. |
| Silica . . . . .            | 35.          | 22. |
| Lime. . . . .               | 33.          | 20. |
| * Klaproth.                 | † Abilgaard. |     |

MARY.

I think I shall know these again when I see them, there is so little variety in the external characters of each species.

MRS. L.

You will find the ores of zinc also very well characterized; they are few in number, but not scarce. At present zinc is found in the states of a sulphuret, an oxyde, and combined with silica and two acids. The sulphuret is called by mineralogists, blende; and by miners, black jack.

FRANCES.

Then I suppose it is black, or nearly so?

MRS. L.

There are three varieties; yellow, brown, and black: the yellow is considered to be a pure sulphuret of zinc; and the greater opacity and darker colours of the other varieties are caused by an intermixture of iron\*.

MARY.

Is this yellow blende? It is not a very bright colour.

MRS. L.

Yes; the yellow inclines to green, and sometimes even passes into it, or it is brownish. You

\* *Analysis of Brown Blende, by Dr. Thomson.*

|         |   |   |   |       |
|---------|---|---|---|-------|
| Zinc    | . | . | . | 59.09 |
| Sulphur | . | . | . | 28.86 |
| Iron    | . | . | . | 12.05 |

will not often see crystals so transparent as these. Some of it is phosphorescent when it is scraped or rubbed, even under water.

FRANCES.

The lustre of the fracture is extremely brilliant.

MRS. L.

It is adamantine—but that is not properly a fracture; it is a cleavage: and blende has six, parallel to the planes of the rhombohedron, its primitive form. Sometimes it is massive, but always with a lamellar structure. Brown blende you have already seen on many specimens of quartz and pearlspar.

MARY.

Yes, in small shining crystals—dark brown or reddish, like garnets.

FRANCES.

The faces of these appear to be convex, so that I cannot understand them.

MRS. L.

That is frequently the case with blende, and the modifications take place in a curious way with regard to the primitive. Here are some very perfect ones (fig. 345); but I have others which I have examined several times without being able to determine their form, because they are partly imbedded.

MARY.

I think the small ones are very much like the little crystals of tinstone.



MRS. L.

They are at first sight, when aggregated together; but the forms are so different from those of tinstone, that a good magnifier will at once enable you to distinguish them: and you may remark that the specific gravity of blende is only about 4, and the streak yellowish-brown. Both these characters will distinguish the brown blende from wolfram, which it resembles a good deal.

FRANCES.

Here is a fibrous specimen very much like blende in colour and brilliancy: is it the same substance?

MRS. L.

Yes; it is radiated blende from Prizbram in Bohemia; it contains several per cent of cadmium: indeed, it was in this that cadmium was first discovered.

MARY.

What is this, Mrs. L., on the other side of the specimen? It appears quite metallic.

MRS. L.

It is sulphuret of lead; a mineral almost always found with blende, whether it occurs in lead-mines or in distinct beds. If you examine these specimens minutely, you will scarcely find one on which there is not some of it.

The black blende is, in general, less translucent than the other varieties; but in small fragments it

appears blood-red when held between the eye and the light. Here is a little bit.

MARY.

The colour is extremely deep.

MRS. L.

An ore of zinc called mammillated blende has lately been observed in Huel Unity, one of the Cornish mines. The oxyde of zinc is of a beautiful cherry-red colour; it has been found hitherto only in North America, in the iron-mines of Sussex county. It does not crystallize, but the structure is lamellar\*.

FRANCES.

Is this magnetic ironstone, which is so much intermixed with it?

MRS. L.

Yes. The colour is lighter, and rather more approaching to orange, than that of red oxyde of copper; and it is soluble in the mineral acids, but does not fuse before the blowpipe. The three following species were formerly confounded together under the name of calamine: afterwards, the silicate was distinguished from the others by its property of becoming electric when it is heated; but it was

\* *Analysis of Oxyde of Zinc by Dr. Bruce.*

|      |   |   |   |   |   |     |
|------|---|---|---|---|---|-----|
| Zinc | . | . | . | . | . | 76. |
|------|---|---|---|---|---|-----|

|        |   |   |   |   |   |     |
|--------|---|---|---|---|---|-----|
| Oxygen | . | . | . | . | . | 16. |
|--------|---|---|---|---|---|-----|

|                              |   |   |   |   |   |    |
|------------------------------|---|---|---|---|---|----|
| Oxydes of iron and manganese | . | . | . | . | . | 8. |
|------------------------------|---|---|---|---|---|----|

not until after many experiments had been made by eminent chemists, that their composition was accurately known. They are all found in the lead-mines of Great Britain; but the silicate only in Leicestershire, Flintshire, and Wanlock Head in Scotland. There are some very perfect crystals on these specimens. (figs. 346, 347.)

MARY.

I suppose they are the small deep yellow-coloured crystals, for all the rest seem to be carbonate of lime and pyrites.

FRANCES.

I remember this crystallization of carbonate of lime, which Mrs. L. said was found principally in Leicestershire.

MRS. L.

The crystals of electric calamine are, in general, very small, and either single or aggregated in little bundles. This substance is soluble in the mineral acids, when warm, and on cooling, gelatinizes. The carbonate of zinc is much more plentiful; it is sometimes crystallized, and frequently massive and compact: but the crystals are always so small and heaped together, that it is scarcely possible to determine their form; they line the cavities of brown ironstone, and other substances which occur with them.

MARY.

These have a sort of radiated arrangement, but there are no single crystals.

FRANCES.

That specimen is very much like one of sulphate of lime that I recollect to have seen, in delicate tabular crystals.

MRS. L.

They are mostly tabular, and greyish or yellowish white; but sometimes a brilliant light-green, which is a much scarcer variety.

MARY.

Here is a light-green specimen, but the crystals are so minute, that it looks like a piece of beautiful moss.

FRANCES.

But how would you find out that it is calamine, and distinguish it from so many minerals of the same colour?

MRS. L.

I think, if you compare it with all the minerals you have seen, you will find very few of the same tint of green; and, if you recollect, I told you it was a *carbonate* of zinc.

FRANCES.

O, true; the effervescence with acids would show it was a carbonate: and the carbonate of copper, I think, does not appear in this form?

MRS. L.

Nor has it this colour. The green copper ores are of rather a bluer tint. The structure of cala-

mine is lamellar, and sometimes a little curved. The compact kind is found massive, and in thin parallel distinct concretions, which have a botryoidal form; and more rarely it occurs in pseudo crystals.

MARY.

Are they hollow?

MRS. L.

Sometimes; but occasionally they are filled with the substances they have incrusted, which are usually carbonate and fluuate of lime.

The earthy calamine contains about 15 per cent of water: it is in general full of cavities and impressions of crystals, and has a good deal of resemblance to cellular quartz; it is opaque and earthy, and adheres to the tongue.

FRANCES.

And it appears to be very soft. I suppose its specific gravity is greater than it seems, from its being cellular?

MRS. L.

The specific gravity of this species is nearly 3.5; that of the crystallized calamine 4.3; and of the red oxyde of zinc 6.22.

MARY.

Which of the ores is used in England for obtaining zinc?



MRS. I.

Both the blende and the calamine. Formerly the blende was entirely neglected, but it is now used in the proportion of one part, to two of calamine. The oxyde, which is abundant in America, is a far more profitable ore; it is melted with copper for the manufacture of brass, without any previous reduction. Sulphate of zinc is a semi-transparent salt, of a greyish or reddish-white colour; it is supposed to be formed by the decomposition of blende, as they occur together. Do you see how that might take place?

FRANCES.

Let me see,—blende is a sulphuret of zinc, and the sulphur it contains must unite with oxygen and become sulphuric acid, to form sulphate of zinc.

MRS. L.

You are right; the process would be the same as in the production of sulphate of iron from pyrites. You will see few specimens of the bismuth ores, for they are scarce minerals: they occur principally in

*Analysis of Zinc Ores, by Mr. Smithson.*

|                     | Silicate. | Carbonate. | Hydrous Carbonate. |
|---------------------|-----------|------------|--------------------|
| Oxyde of zinc ..... | 68.3      | 64.8       | 71.4               |
| Silica .....        | 25.       | —          | —                  |
| Water .....         | 4.4       | —          | 15.1               |
| Carbonic acid ..... | —         | 35.2       | 13.5               |



Saxony; and the native bismuth is more common than the other species. This is from Schneeberg.

MARY.

It is very much like one of the cobalt ores, both in colour and lustre.

FRANCES.

Yes; and like the native tellurium.

MRS. L.

It is softer and more sectile than the cobalt ore, and its chemical properties are very different from those of cobalt and tellurium. It is easily melted, and converted into a metallic globule by the blow-pipe; and by continuing the heat, it is volatilized in the form of a white smoke, which may be condensed on a piece of charcoal held over it: it mostly occurs intermixed with cobalt ores.

MARY.

Has it always this foliated granular appearance?

MRS. L.

No; it is sometimes crystallized in acuter rhombs, and octahedrons.

FRANCES.

And which of the two is the primitive?

MRS. L.

The rhomb, most probably, as it appears to have a threefold cleavage. Occasionally it is found, like native silver, in leaves and dendritic forms, in quartz or hornstone, and other substances. It

has been obtained from some of the Cornish mines in small quantity. The sulphuret of bismuth has a darker colour, and a less metallic lustre.

MARY.

Will the blowpipe volatilize the sulphur?

MRS. L.

Yes; but the greater part of the metal is volatilized by the heat at the same time: it melts even in the flame of a candle.

FRANCES.

Is this sulphuret of bismuth, Mrs. L.? there seem to be two kinds of metal, one partly inclosed in the other, and the whole imbedded in quartz.

MRS. L.

It is a sulphuret containing copper and lead, called needle ore, from its occurring in acicular crystals; it is inclosed in sulphuret of lead. In some of the mines near Wittichen in Furstemberg, a cupreous sulphuret of bismuth occurs in acicular crystals, and massive: the fracture is fine-grained, uneven, and it is sectile.

MARY.

I am afraid I shall not easily recognise these bismuth ores. They are like several other minerals.

MRS. L.

Not by their external appearance perhaps; but then you must have recourse to your blowpipe.

The needle ore fuses into a steel-grey globule; and by continuing the heat it is partly volatilized, and deposits a yellow powder on the charcoal: after which there remains a red globule inclosing a grain of melted lead. The oxyde of bismuth is a light, greenish ochry mineral, like the nickel ochre in external appearance.

MARY.

Is it easy to distinguish them?

MRS. L.

There are two methods: the most simple is to dissolve a little in one of the mineral acids, and add a considerable quantity of water; if it be an ore of bismuth, the oxyde of bismuth will be precipitated in the form of a white powder.

There is very little variety in this genus, but in the next, a great deal.

FRANCES.

Is it the lead genus? I see some specimens exactly

|                   | *<br>Sulphuret of<br>Bismuth. | †<br>Cupreous<br>Sulphuret. | ‡<br>Needle Ore. |
|-------------------|-------------------------------|-----------------------------|------------------|
| Bismuth . . . .   | 60.                           | 47.24                       | 43.20            |
| Sulphur . . . .   | 40.                           | 12.58                       | 11.58            |
| Copper . . . .    | —                             | 34.66                       | 12.10            |
| Lead . . . . .    | —                             | —                           | 24.32            |
| Nickel . . . . .  | —                             | —                           | 1.58             |
| Tellurium . . . . | —                             | —                           | 1.32             |
| Loss . . . . .    | —                             | 5.52                        | 5.90             |
| * Sage.           | † Klaproth.                   | ‡ John.                     |                  |

like the sulphuret of lead, with a very distinct rectangular cleavage in three directions.

MRS. L.

That is sulphuret of lead; it is commonly called galena. The cleavages are very easily obtained, even by dropping a piece on the floor; for though it is soft, it is very frangible:—But you have overlooked the first species, native lead.

MARY.

I suppose, from seeing such a small piece, that it is very scarce?

MRS. L.

It is extremely rare: this was discovered at Holywell in Flintshire, where there are lead-mines. Galena, on the contrary, is a very abundant ore in many countries. By far the greater part of the lead used in the different manufactures is obtained from it. The most common crystals are octahedrons, and cubes with their angles deeply truncated (figs. 349, 350); but it assumes other forms derived from the cube. The crystallized specimens are generally very pretty, because the galena is associated with carbonate and fluuate of lime, pearlspar, sulphate of barytes and quartz; as well as other ores.

FRANCES.

The colour is very much like that of lead; is there much difference in their specific gravity?

MRS. L.

The specific gravity of galena is between 7.5

and 7.8; that of lead, you know, is above 11. The crystals generally appear resting on those of the other minerals, like those of blende and calamine, and not imbedded.

MARY.

There are beautiful iridescent colours on this specimen; is that uncommon in galena?

MRS. L.

No; they do not extend below the surface. Here is another variety, called compact or steel-grained galena from its texture: it has less lustre than the other, and does not crystallize.

FRANCES.

Are both kinds found in England?

MRS. L.

Yes; but the compact galena is much more scarce than the other. Galena oftens contains a little silver; sometimes even as much as 15 per cent in the lead obtained from it. When this is the case, it is worked for the sake of the silver it contains.

MARY.

But I suppose the lead is procured from it too?

MRS. L.

Yes. The lead is first procured from the ore in the usual way; it is afterwards separated from the silver by a process called cupellation: while it is in a state of fusion, a current of air passes over it, which oxydates the lead and converts it into a yellowish scaly substance called litharge. This is

blown off by the draught of air, and is again formed on the surface of the melted metal, till the silver, which is not affected by the oxygen of the air, remains nearly pure at the bottom of the furnace. A second cupellation removes the small quantity of lead which was left by the first operation.

FRANCES.

But is all the lead wasted?

MRS. L.

No; the greater part of the litharge is re-converted into metallic lead by the same means as are employed to reduce the ore. Some of it, however, is used in that state.

When the fracture of galena is slightly fibrous, it contains a small portion of antimony. The species called antimonial sulphuret contains about equal parts of lead and antimony; it has a very peculiar glistening lustre, and is not uncommon in the English lead-mines.

MARY.

This is dendritic, and contains small crystals of carbonate of lime.

MRS. L.

The next is a specimen of a very curious substance, though it has nothing remarkable in its appearance. It is a kind of galena, which is found in Derbyshire, lining the sides of very narrow rents or fissures in the rock, and, from the smoothness of its surface, is called *slikenside*, or *sleekinside*.



FRANCES.

Is it not curious, on account of its smoothness and shining lustre?

MRS. L.

No; but if it is struck, when in its original situation in the mine, with a hammer or any other hard substance, so as to break the surface, it crackles and then breaks to pieces with an explosion.

MARY.

How very strange! and will this explode in the same manner if you scratch it?

MRS. L.

No, not after it is removed from the rock. The miners are aware of this property; and I was told by one (when I was in Derbyshire), that if they find out the slikenside before any accident occurs, they go out of the way, leaving one man, who hits it with a nail fastened to the end of a long pole, and runs away to avoid the effects of the explosion. This man had been wounded by the sudden breaking of some slikenside in the Gang Mine, at Cromford level; and of his eight companions, some were wounded, and some killed.

FRANCES.

And has this never been accounted for?

MRS. L.

Not satisfactorily.

FRANCES.

And what are these black hexagonal prisms? Here is a large group of them.

MRS. L.

It is called blue lead ore, but the colour is dark blueish grey,—it is black and dull, only on the surface. These are not perfect hexagonal prisms, but are thicker in the middle than at the terminations. (fig. 353.)

MARY.

So they are; I never observed that in any other substance.

MRS. L.

The prisms of arseniate of lead have the same form. This species has not been analysed, but they have been supposed to be a mixture of sulphuret, with phosphate of lead. It has been found only at Schoppau in Saxony, and Huelgoet in Brittany.—Those are specimens of bournonite.

FRANCES.

Pray, was it named after the Comte de Bournon, whom I have heard you speak of as a mineralogist and crystallographer?

MRS. L.

Yes. He first described it, and examined its crystallizations: he had called it endellion, because it was discovered in a parish of that name in Cornwall.

MARY.

I cannot understand the crystals, because they are so closely aggregated that I can only see a small part of them.

MRS. L.

They seldom occur single; and as they are divisible by cleavage into two prisms, a rectangular and a rhombic one, there might be some doubt respecting the primitive form. Bournon considered it to be a square prism, but Mr. Phillips and Mr. Brooke have lately determined it to be a rectangular one. (fig. 354.) The crystals always exhibit several modifications.

FRANCES.

I should think the cleavages were not easily obtained; for the fracture of these appears to be uneven.

MRS. L.

They are not very distinct. It is brittle, and in hardness is intermediate between carbonate of lime and fluor. The crystals are dull and nearly black externally, but the colour of the fracture is dark grey.

MARY.

What is the difference in the composition of this and galena?

MRS. L.

It contains sulphuret of antimony, of copper, and of iron. It decrepitates and splits before the

blowpipe; and the antimony and part of the sulphur are volatilized, leaving a globule of copper incrustated by sulphuret of lead.

FRANCES.

And what becomes of the iron?

MRS. L.

The quantity is so small (from about 1 to 3 per cent) that it is not rendered visible by this operation. There is also an ore of lead containing cobalt, and another containing a good deal of arsenic; but both are extremely scarce: the two natural oxydes are also very rare.

MARY.

Have you any of them?

MRS. L.

Yes; this is the yellow oxyde from Siberia: it has a good deal of resemblance to yellow jasper.

|                 | *            †<br>Galena. |     |       | ‡<br>Bournon-<br>ite. | §<br>Antimonial<br>sulphuret. |
|-----------------|---------------------------|-----|-------|-----------------------|-------------------------------|
| Lead . . .      | 69.                       | 64. | 85.13 | 42.5                  | 43.44                         |
| Antimony . .    | —                         | —   | —     | 19.75                 | 42.26                         |
| Copper . .      | —                         | —   | —     | 11.75                 | 0.18                          |
| Iron . . .      | —                         | —   | 0.5   | 5.                    | 0.16                          |
| Arsenic . .     | —                         | —   | —     | —                     | 3.56                          |
| Sulphur . .     | 16.                       | 18. | 13.02 | 18.                   | 17.20                         |
| Lime and silica | 15.                       | 18. | —     | —                     | —                             |
| Loss . . .      | —                         | —   | 1.35  | 3.                    | —                             |
| * Vauquelin.    | † Thomson.                |     |       | ‡ Klaproth.           | § Pfaff.                      |

FRANCES.

Yes, but its weight would distinguish them; and I suppose it is a great deal softer than jasper?

MRS. L.

Yes; a knife will scratch it easily: the specific gravity is 8. In the less compact varieties there is an indistinct threefold cleavage. Both this and the red oxyde are easily reduced on charcoal. You have seen the red lead used in painting?

MARY.

Yes; is this scarlet earthy mineral the same substance?

MRS. L.

Precisely. This is supposed to be produced by the decay of galena; which is very probable, for sometimes it occurs in cubes, or contains galena within it: it is not so beautiful a colour as the light-red cinnabar.

FRANCES.

No; this inclines to orange, and is less compact.

MRS. L.

This ore has been met with in the lead-mines of Yorkshire, as well as some places on the Continent.—The next family is extensive, and presents a good deal of variety. The combinations of lead with the different acids are rather numerous.

MARY.

I think the acidiferous ores have seldom any me-

tallic lustre: they resemble earthy minerals very much in their external characters.

MRS. L.

You see, therefore, the necessity of being acquainted with the means of ascertaining their composition. The carbonate of lead is an ore more frequently met with than any other except galena. I do not know whether you will find any resemblance in these specimens to those you have seen.

FRANCES.

From their great weight, I think it is very likely that I might mistake them for sulphate of barytes; but some of these crystals have a peculiar brilliancy, different from the lustre of any thing I remember.

MRS. L.

The internal lustre is always adamantine, though the surface of the crystals varies from that to dullness. Indeed, it exceeds the diamond in brilliancy when it is transparent; and if it were sufficiently hard, would doubtlessly be preferred to it as a precious stone. This is owing to its very high refractive power.

MARY.

Does it refract doubly, like carbonate of lime?

MRS. L.

Yes, in a high degree; but it is seldom very transparent. The primitive crystal was till lately thought to be an octahedron with a rectangular



base, as the carbonate of lead occurs in that form, and has cleavages parallel to all its faces; but the crystals may be cleaved in other directions, one of which, together with two parallel to the faces of the octahedron, afford a right prism with a rhombic base.

FRANCES.

Here is an octahedron which appears to be of that kind. (fig. 357.)

MRS. L.

It is one which I obtained by splitting a crystalline fragment.

MARY.

Are not these like quartz crystals? (fig. 360.)

MRS. L.

Yes; but the angle made by the planes of the prism and the pyramid is different from that of quartz; and the base of the prism, or a section perpendicular to the axis, is not a regular hexagon\*. Carbonate of lead is generally crystallized, but sometimes massive and intermixed with the galena or copper ores that frequently occur along with it:—this is a pretty variety.

FRANCES.

O! I have seen something exactly like that before, though I do not remember what it was.

\* In each of these prisms (figs. 358 and 360) two angles are formed by the meeting of the primitive planes, and are  $117^{\circ} 18'$ . The remaining four are each  $121^{\circ} 21'$ .

MRS. L.

It was the columnar sulphate of barytes: this is from Shropshire. It is tinged by the brown iron-stone that occurs with it; and several of these specimens are of beautiful blue or green tints, in consequence of being associated with carbonate of copper.

MARY.

I suppose it would not be difficult to distinguish this from the sulphate of barytes, as it is a carbonate?

MRS. L.

No; the effervescence with acids is a very simple test. It will also prevent you from mistaking the earthy variety for earthy calamine: they are sometimes very similar. The friable earthy carbonate has generally a yellow tinge; and the indurated kind is of different shades of grey and light-brown. These are crystals of carbonate of lead, of which the external part has been reduced to a metallic state, or rather to the state of a sulphuret, while the centre retains its original transparency.

FRANCES.

Here is a broken one, which shows it very plainly.

MARY.

How does that change take place in them?

MRS. L.

It is most probably occasioned by sulphuretted

hydrogen, produced by the decomposition of galena. I will show you how it acts, directly: Here is a little powdered carbonate of lead, and a small cup containing sulphuret of potash, on which I will pour some nitrous acid\*, and cover the whole with a glass bell, to prevent the escape of the gas produced, which is sulphuretted hydrogen.

MARY.

How violently it effervesces!

FRANCES.

It is already beginning to blacken the carbonate of lead.

MRS. L.

The property of becoming black, by exposure to sulphuretted hydrogen, is a good distinctive character between this ore and the minerals which it most resembles. You might at first mistake the crystals on this specimen for carbonate of lead.

MARY.

I think I should. Their lustre is much the same.

MRS. L.

These are the sulphato-tricarbonate, a compound of one part of carbonate with three parts of sulphate of lead. The crystals, which are in general rather complicated, appear to be derived from an acute rhomboid†. One of its modifications (as of all primitive rhomboids) tends to produce a hexagonal

\* Sulphuric or muriatic acid may be substituted.

† Of  $72^{\circ} 30'$  and  $107^{\circ} 30'$ .

prism; so that the crystals often resemble those of carbonate of lime.

FRANCES.

I suppose then, that I ought to know it by examining its crystallizations?

MRS. L.

You will not always find that easy; but you may remember that it is harder than carbonate of lead, and has not the same cleavages. The sulphato-carbonate of lead occurs in very minute crystals aggregated laterally, and is softer than the carbonate.

MARY.

Will either of these species effervesce with acids?

MRS. L.

The sulphato-carbonate, on the application of nitric acid, effervesces, but very feebly.—Here is another variety.

FRANCES.

I should certainly have thought it a copper ore if I had not seen it in this drawer.

MRS. L.

It is the cupreous-sulphato-carbonate of lead. Its blue colour is undoubtedly owing to the carbonate of copper which it contains. The minute crystals are tabular, and often much modified.

The last three species have been observed hitherto only at Lead Hills in Scotland. The carbonate, particularly the earthy variety, is very generally distributed in the great lead veins of most countries. The next species is the murio-carbonate,

a still rarer substance. It has been observed in Derbyshire, and some parts of Germany and America, always crystallized.

MARY.

Here is a beautiful crystal (fig. 362), a square prism terminated by pyramids; but it appears a little twisted.

MRS. L.

Most of the long prisms have that appearance; but the shorter ones are quite straight. There is a remarkably fine crystal of this form (fig. 363) in the British Museum, nearly two inches in diameter: it is from Derbyshire. It has a brilliant adamantine lustre, but is rather softer than carbonate of lead, and easily frangible, but sectile. The specific gravity is 6. The cleavages are parallel to the sides of a square prism, but the cross fracture is conchoidal.

FRANCES.

Does it occur of no other colour than yellowish-white?

MRS. L.

It is sometimes colourless, and sometimes the yellow tinge is a little deeper than in this specimen. The colour of phosphate of lead passes from pistachio green into honey-yellow, and deep orange, and different tints of brown: it has been distinguished into different subspecies, according to its colour, but their composition and crystallization



are exactly the same.—These specimens are from Siberia, and are very well crystallized.

MARY.

The crystals are rather small; but I can see two or three forms like those of emerald.

FRANCES.

They are hexagonal prisms: some of them have the terminal edges truncated.

MRS. L.

It is not very uncommon to find the prisms terminated by low pyramids, similar to the terminations of phosphate of lime (figs. 212, 213, 214); indeed there are no crystals of this substance which may not be found in apatite. The orange-coloured variety is from Lead Hills in Scotland. Here is one exactly like the green calamine you admired.

MARY.

It is, indeed. I should think it impossible to know them by their external appearance.

MRS. L.

When phosphate of lead is exposed to the action of the blowpipe, on charcoal, it decrepitates a little, and then melts; and when it is cooled very slowly, assumes a polyhedral form, and the faces exhibit numerous concentric polygons: but this does not take place till it has been some minutes in a state of fusion, and when you are beginning to withdraw



it from the hottest part of the flame. This is a little bead I obtained by such a process.

FRANCES.

How very brilliant the faces are; it appears quite metallic.

MRS. L.

I do not know any thing for which you could mistake it, after making this experiment. Phosphate of lead is soft, but not so frangible as carbonate of lead. The green crystals are usually translucent on the edges.

FRANCES.

And they have rather a waxy appearance. Is this botryoidal specimen another variety of the same substance?

MRS. L.

No, that is arsenio-phosphate; it contains 7 per cent of arsenic acid, and has a fibrous or radiated fracture: this has not been found in England hitherto. One of the most beautiful lead ores is the chromate, which is peculiar to a gold-mine near Ekaterinebourg in Siberia. It occurs only crystallized, and of a colour sometimes called aurora-red.

MARY.

That is a beautiful colour, and I think different from any other I have seen.

MRS. L.

It is intermediate between blood-red and bright-orange.

FRANCES.

Are not these crystals four-sided prisms?

MRS. L.

Yes: the angles of the prism differ but little from those of a cube \* (fig. 364). They are acuminated by four planes, and some of them have other additional faces.

This is the result of a singular modification (fig. 366), which takes place on only one of the lateral edges. It is difficult to understand the crystallizations of this mineral: one or two planes are generally much larger than the rest, and give them an appearance of irregularity; and several crystals are often grown together. When it is reduced to powder, it is of a rich yellow colour.

MARY.

It is a great pity it is so scarce: I should think it might be used for painting?

MRS. L.

Chromate of lead is prepared artificially for that purpose, and is one of the finest yellows that can be used in oil-painting. The chromic acid is obtained from the chromate of iron, which is found abundantly in North America; and the colour is generally called chrome-yellow.

FRANCES.

I believe, then, I have seen it: but is it permanent? For I remember you once told me not to

\* They are  $93^{\circ} 30'$  and  $86^{\circ} 30'$ .

paint any thing with red lead or flake white, because they would change to lead in a little time.

MRS. L.

Yes, because the flake white is carbonate of lead; and there is a great deal of sulphuretted hydrogen always floating in the atmosphere of large towns. But the chromate of lead is not affected by any of the gases that are so abundant in the air of London. The yellow coach-bodies are now generally painted with it, instead of the submuriate of lead which was formerly used for that purpose. The specific gravity of it is 6. The sulphate of lead is not very plentiful. The best crystals I have are from the Parys mine in Anglesea.

MARY.

What is the mineral these crystals are partly imbedded in? (fig. 369.) It has the appearance of a brown cinder.

MRS. L.

It is cellular quartz coloured by iron ochre, and intermixed with iron pyrites. The crystals are generally small; the primitive form is a right rhombic prism (fig. 367), which is usually so modified as to have the appearance of an elongated octahedron (fig. 371), or a figure derived from it. (fig. 370.)

FRANCES.

Some of them are rather complicated, and none are bright.

MRS. L.

With a glass I think you will not find it difficult to see most of the planes : they are in general very regular.

MARY.

Is this the same substance, Mrs. L., in thin, flat, shining pieces attached to galena ?

MRS. L.

Yes, that is from Lead Hills ; it is a good deal like some of the tabular varieties of the sulphate of barytes, but has a much more brilliant lustre externally. The specific gravity is about 6.3, a little less than that of carbonate of lead.

I have a singular specimen of galena enveloped in sulphate of lead, which has nearly the appearance of clay-ironstone. You see there is a good deal of galena diffused through the whole mass.

FRANCES.

Do you think it might once have been entirely galena, and that the sulphur has become sulphuric acid ?

MRS. L.

You have given a very good explanation of it, and most likely the true one.

MARY.

Here is another beautiful blue mineral. Is it coloured by copper ?

MRS. L.

Yes, it is the cupreous sulphate of lead ; another

variety, which has lately been observed at Lead Hills. It very much resembles the transparent crystals of blue carbonate of copper, and in hardness is intermediate between the sulphate and carbonate of lead. There is very little variety in the next species, which is molybdate of lead.

MARY.

Is not that lead combined with acid of molybdena?

MRS. L.

Yes: it is very seldom found in masses; mostly in small crystals of a wax or honey-yellow colour.

FRANCES.

Some of them are very flat octahedrons, and some are thin tables, like those of uran-mica.

MRS. L.

The flat octahedron (fig. 372), though one of the most common forms of molybdate of lead, is not the primitive one: like that in tungstate of lime, it is derived from one much more acute\*. The octagonal tables you may imagine to be produced by deeply truncating the summits and all the lateral angles. (fig. 374.)

MARY.

I think there are several minerals something like this; therefore I hope it has some peculiar character or property by which I may know it again.

\* The angle made by adjoining faces of the two pyramids is  $130^{\circ} 15'$ .

MRS. L.

If you dissolve a little in hot sulphuric acid, the solution will have a blue colour;—that is a very simple experiment: or if you submit it to the action of the blowpipe, you will find that it fuses into a yellowish-grey glass, and part of the lead is reduced to metallic globules. It is found in Austria, Transylvania, the Tyrol, Carinthia (where it was first discovered), and Massachusetts in North America.

The arseniate of lead was a very rare mineral till a good deal was discovered some years ago in Cornwall. It occurs in slender hexagonal prisms, which rest upon crystals of quartz, and steatite: these are from the mine Huel Unity in Cornwall.

FRANCES.

How very silky their lustre is; they look like a collection of delicate fibres.

MARY.

I do not see any regular terminations.

MRS. L.

They very seldom occur; but sometimes the terminal edges of the prism are replaced by narrow planes. It is generally of a brownish or straw-yellow colour, but it is said to have been observed grass-green. This reniform variety is from Siberia; and there is another, having nearly the same appearance, which contains above forty per cent of antimoniac acid. A tungstate of lead has lately



been found at Zinnwalde in Bohemia, and was first made known in England by Mr. Heuland. I have seen a specimen in his possession; it is somewhat similar to the acicular brown phosphate, but the crystals are parts of very acute square pyramids. (fig. 377.)

FRANCES.

I do not suppose this is it; is it another ore of lead?

MRS. L.

Yes, it is a combination of lead and alumina; that is, an aluminate of lead, sometimes called plombgomme. Except in its yellow colour and less degree of transparency, it is a good deal like hyalite.

MARY.

But this has a thin crust, nearly opake, and it is very heavy.

MRS. L.

I do not know the specific gravity of it: it is a very scarce mineral, and found only at Huelgoet in Brittany. Of all the lead ores, galena is by far the most abundant; the lead smelted in Great Britain, which is chiefly obtained from it, varies from 45 to 48,000 tons annually.

FRANCES.

What an immense quantity!

MARY.

I cannot imagine how so much can be used every year.

|                 | * Carbon-ate of lead. | † Earthy lead ore. | ‡ Muriocarbonate. | * Phosphate of lead. | § Chromate of lead. | * Sulphate of lead. | Molybdate of lead. | ** Arseniate of lead. |
|-----------------|-----------------------|--------------------|-------------------|----------------------|---------------------|---------------------|--------------------|-----------------------|
| Oxide of lead   | 82.                   | 66.                | 85.               | 78.4                 | 64.                 | 70.50               | 58.4               | 69.76                 |
| Oxide of iron   | —                     | 2.25               | —                 | 0.1                  | —                   | —                   | 3.08               | —                     |
| Carbonic acid   | 16.                   | 12.                | 6.                | —                    | —                   | —                   | —                  | —                     |
| Muriatic acid   | —                     | —                  | 8.                | 1.7                  | —                   | —                   | —                  | 1.58                  |
| Phosphoric acid | —                     | —                  | —                 | 18.37                | —                   | —                   | —                  | —                     |
| Arsenic acid    | —                     | —                  | —                 | —                    | 36.                 | —                   | —                  | 26.40                 |
| Chromic acid    | —                     | —                  | —                 | —                    | —                   | —                   | 37.                | —                     |
| Molybdic acid   | —                     | —                  | —                 | —                    | —                   | 25.75               | —                  | —                     |
| Sulphuric acid  | —                     | —                  | —                 | —                    | —                   | —                   | 0.28               | —                     |
| Silica          | —                     | 10.50              | —                 | —                    | —                   | —                   | —                  | —                     |
| Alumina         | —                     | 4.75               | —                 | —                    | —                   | 2.25                | —                  | —                     |
| Water           | —                     | 2.25               | —                 | —                    | —                   | 1.50                | —                  | —                     |
| Loss            | 2.                    | 2.25               | 1.                | 1.43                 | —                   | —                   | 1.24               | 2.26                  |
| * Klaproth.     | † John.               | ‡ Chenevix.        | § Thenard.        | Hatchett.            | ** Gregor.          |                     |                    |                       |

MRS. L.

A great part of it is exported to China and to Holland; and, in England, it is used principally by the plumbers, or converted into red and white paint. But as much is smelted in Great Britain as all the mines in the rest of Europe produce.

|                          | Sulphato-<br>carbonate<br>of lead. | Sulphato-<br>tricarbonate<br>of lead. | Cupreous<br>sulphato-<br>carbonate. |
|--------------------------|------------------------------------|---------------------------------------|-------------------------------------|
| Carbonate of lead . . .  | 47.9                               | 72.5                                  | 32.8                                |
| Sulphate of lead . . . . | 53.1                               | 27.5                                  | 55.8                                |
| Carbonate of copper. . . | —                                  | —                                     | 11.4                                |

Analysed by H. J. Brooke, Esq.

## CONVERSATION XVIII.

FRANCES.

I HAVE been thinking of all the minerals we saw yesterday, and trying to recollect them; but there are so many ores of lead, that I feel quite puzzled about them.

MRS. L.

I should be much more surprised if you had remembered them all: but you will find it some assistance to your memory to consult the table\* I gave you of the different combinations of metals; and I would recommend you to go frequently to the British Museum, where you will see a large collection of fine minerals, systematically arranged and named.

There are but two metals whose ores you have not seen,—antimony and arsenic: they are both found in a native state, as well as mineralized by other substances. This is native antimony from Andreasberg in the Hartz.

MARY.

I think it is whiter than most of the native metals.

\* Page 91. See also the Tabular System at the end of this volume.

MRS. L.

Yes, it is nearly silver-white; and the foliated surfaces of the fracture are larger than in other ores that have the same kind of structure: it has ten cleavages, which are parallel to the faces of the octahedron and the rhombohedron. It is soft, and easily broken, and the specific gravity is about 6.7.

FRANCES.

Is it found in sufficient quantity to work as an ore of antimony?

MRS. L.

No: it has been found in several of the mining districts of the Continent, but very sparingly. The sulphurets are the most abundant of its ores.

MARY.

How very much these are like the specimens of grey manganese ore.

MRS. L.

The radiated varieties have certainly a great deal of similarity; but the colour of grey manganese ore is generally deeper than that of sulphuret of antimony; and perhaps you remember an experiment I told you of, which would immediately decide the question.

FRANCES.

Yes; if I melt a little manganese ore with borax, I shall get a purple glass.

MRS. L.

And you may remember that before the blow-

pipe, antimony evaporates in the form of a grey vapour. The compact sulphuret is very nearly of the same colour as the compact galena; but its specific gravity is not above 4.4: that of the foliated variety is about the same, but the colour is rather lighter.

MARY.

What is this, Mrs. L.? It appears of all colours and quite brilliant.

MRS. L.

It is the radiated grey antimony with an iridescent tarnish, sometimes called peacock antimony ore; but the colour of the fracture is like that of the other kinds. It is found in several places in Germany and France; but antimony ores are very scarce in Great Britain.

FRANCES.

In what part of England are they met with?

MRS. L.

In Cornwall, at St. Stephen's and in Huel Boys mine, near Padstow; and in Scotland, at Glendinning in Dumfries-shire.

The most uncommon variety is the plumose sulphuret of antimony. Here is a specimen intermixed with very small quartz crystals.

MARY.

How curious that is! it looks like down.

FRANCES.

And it feels quite soft.



MRS. L.

It consists of very delicate capillary crystals. I dare say you will find some on your finger after touching it.

FRANCES.

Yes, here are a few, like fine hairs.

MARY.

The radiated specimens are crystallized, and they seem to me very much like those of grey manganese. (figs. 378, 379, 380.)

MRS. L.

In general form they are; but, if you compare the terminations, you will see the difference. Häüy supposed the primitive to be an oblique rhomboidal octahedron, but the only decided cleavage is parallel to the axis of the prism.

These minerals are, in general, found in veins that contain galena, blende, and iron and copper pyrites; and sometimes with gold and silver ores. Another species, containing above 23 per cent of nickel, is occasionally found at Freussberg in Nassau. In colour and texture it is very much like the compact grey ore; but it is brittle and rather harder.

FRANCES.

Are there any oxydes of antimony?

MRS. L.

Yes: here is the white oxyde in detached crystalline fragments.

MARY.

It is very translucent, and appears to have *one* distinct cleavage.

MRS. L.

Yes: parallel to one side of a rectangular prism: it is very uncommon to find any regular terminations; so that these fragments can hardly be termed crystals. It has rather a pearly lustre, and sometimes occurs in tufts of acicular crystals. The red oxyde contains sulphur.

FRANCES.

Surely I have seen some ore very like this, both in colour and form?

MRS. L.

Yes, the radiated arseniate of cobalt; but this has, generally, more lustre: the specific gravity is about 4.

MARY.

What colour do you call it?

MRS. L.

It is a deep cherry-red, with sometimes a slight purple tinge. The white mineral, associated with it, is carbonate of lime: one variety of this has been called tinder-ore.

FRANCES.

Why? will it take fire as tinder does, from a spark?

MRS. L.

No, it is so called from its texture; it occurs in these soft leaves, like felt: they are composed of extremely delicate fibres, interlaced, and are perfectly flexible. Their colour is dark reddish-brown. This differs also from the crystallized variety, in containing a good deal of silver; so that at Clausthal in the Hartz it is worked as a silver ore. There is still another oxyde of antimony which is an ochry mineral of a straw-colour. It may be distinguished from the yellow oxydes of several other minerals, by its evaporating before the blowpipe without melting.

MARY.

Are there any more ores of antimony?

MRS. L.

No; it has not been found in combination with any of the mineral acids—neither has arsenic; its ores are nearly the same as those of antimony.

FRANCES.

They will be easily distinguished from other minerals by the blowpipe.

MRS. L.

Yes; the arsenical fumes arise almost immediately on the application of heat, and very copiously. The colour of native arsenic, when fresh broken, is pale lead-grey; but you see how much darker this has become by exposure to the air. It

does not crystallize, but frequently has pyramidal and cubical impressions.

MARY.

The form is like that of malachite,—large botryoidal.

MRS. L.

Yes, the concentric concretions are sometimes very distinct: when it is struck by a piece of metal, it has a peculiar sound; you may try it with a key.

FRANCES.

It has a slight ringing sound—very slight.

MARY.

What is the specific gravity of it?

MRS. L.

About 5.7, so that it cannot be pure\*. Pure sulphuret of arsenic is a beautiful substance; there are two varieties of it, called red and yellow orpiment.

FRANCES.

I think this is exactly like the colour of chromate of lead.

MRS. L.

It is aurora-red, but darker than chromate of lead, and sometimes approaching to a crimson. Here are some tolerably perfect crystals, and very translucent. (figs. 382, 383.)

\* The specific gravity of pure arsenic is 8.91.

MARY.

They seem to be four-sided prisms, variously modified.

MRS. L.

They are supposed to be derived from an octahedron, with isosceles triangular faces (fig. 381); but as there is no cleavage to direct us, this is at present conjectural.

FRANCES.

But these yellow specimens appear to have a very distinct cleavage.

MRS. L.

Yes, in one direction; but it does not crystallize: the colour is extremely rich and beautiful, and it has a good deal of resemblance to talc: but yellow orpiment is seldom so translucent and lamellar as this; it is more frequently earthy and opake.

MARY.

I think I have heard of orpiment; is any use made of it?

MRS. L.

Yes, king's yellow is made from it; and from the red variety (which is called realgar), a fine colour is prepared: but they are often intermixed, as in these specimens.

FRANCES.

In what part of the world is it found?

MRS. L.

The finest crystals of realgar are got in Bohemia, and in the dolomite of Mount St. Gothard; and it is found abundantly in Saxony and the Hartz. The yellow orpiment occurs in the Hartz and several parts of Germany, but not abundantly in the localities of realgar. Their specific gravity is not above 3.4.

MARY.

What are these whitish metallic crystals?

MRS. L.

They are arsenical iron; a mineral which is unfortunately very abundant in many of the Cornish mines. (figs. 385, 386.)

FRANCES.

Is it of no use, then?

MRS. L.

White oxyde of arsenic and artificial orpiment may be prepared from it; but it is frequently too much intermixed with the tin and copper ores to be separated from them without considerable trouble; and a great deal of metal is thus wasted.

MARY.

The little crystals are very bright and perfect. What is the substance they are imbedded in?

MRS. L.

A decomposing granite, on which you may find likewise crystals of arseniate of lead, and traces of green copper ore.



FRANCES.

None of these forms are very complicated ; I think they are easy to understand.

MRS. L.

The crystals offer but few modifications, and are seldom distorted by the extension of one or two planes, as is often the case with other substances. Sometimes, however, the faces are curved.

MARY.

This is much whiter than iron-pyrites ; is it as hard ?

MRS. L.

It will give sparks with steel ; and at the same time you will perceive the smell of garlic, which characterizes arsenic. These acicular crystals contain a portion of silver ; the quantity varies from 1 to 15 per cent ; and the ore is worked for silver.

FRANCES.

I suppose this is not so abundant as the other kind ?

MRS. L.

No ; it has been found only in Saxony, Salzburg, and Chili. Here is a radiated variety in carbonate of lime.

The last ore is the natural oxyde of arsenic : some of it is very like pharmacolite.

MARY.

I forget what that is. Has it another name ?

MRS. L.

Arseniate of lime; but this is easily distinguished from it by being soluble in water: and sometimes it occurs in capillary crystals, so delicate, that the little tufts resemble those which appear on mouldy substances.

FRANCES.

Here is a greenish earthy mineral; is it oxyde of arsenic?

MRS. L.

Yes; it is a variety found at Nertschinsk in Siberia, containing sometimes pale-coloured beryls imbedded in it: but this is not common.

MARY.

And are there no more ores to see?

MRS. L.

No; but there is another class of minerals, which you have perhaps forgotten.

FRANCES.

The inflammables? O, no! I have not forgotten them, for I have been anxiously wishing to see the crystallized diamonds.

MRS. L.

Well, I hope you will not be disappointed in them; but to persons who neither understand mineralogy nor crystallography, they must appear insignificant or worthless; and some of the most curious crystals are the smallest.

MARY.

Are the primitive crystals scarce?

MRS. L.

They are not often found entirely free from modification. Here is one quite perfect. (fig. 389.) You had better have a magnifier.

FRANCES.

The edges are quite sharp, and it is very bright.

MRS. L.

Some of the crystals are rough, and nearly dull, externally.

MARY.

How curious this is, Mrs. L. ! (fig. 390.) It is like the model you showed us of a rhomboidal dodecahedron, arising from an octahedron.

MRS. L.

It exhibits the laminae of superposition very well. The most common forms of the diamond are these. (figs. 392, 393.)

FRANCES.

How very convex the faces of some are !

MRS. L.

Yes ; there is a great tendency to convexity in most crystallizations of the diamond. The edges of the octahedron are seldom truncated by a single plane, as in this (fig. 391), but in general by two narrow convex surfaces. (fig. 392). Cubes may be

reckoned among its least common forms : they are always dull, and mostly dark coloured. If you look obliquely on this, you will see the glisten of the laminae parallel to the primitive faces. These are macles of octahedrons modified by a flat pyramid on each face, and of dodecahedrons with divided faces. (figs. 396, 397.)

MARY.

The re-entering angles are not visible in these macles.

MRS. L.

That is partly owing to the convexity of the faces. Here is a diamond almost spherical.

FRANCES.

Is that a crystal ?

MRS. L.

No ; it seems to be the result of a confused crystallization, which produces a sort of radiated structure. The round diamonds will not, like the crystalline ones, yield to cleavage ; and are so hard (on this account) that they cannot be rubbed down in the usual way ; so that they are only fit to break up for diamond powder, with those which are of a bad colour or full of flaws.

MARY.

Scarcely any of these are quite colourless : they have a greenish or brownish tinge.

MRS. L.

Colourless diamonds are much less common than you perhaps imagine, from knowing them to be principally used in jewellery. The rarest colours are blue, pink, and dark brown: but yellow diamonds, when the colour is clear and equal throughout, are very beautiful and much valued. I never saw one perfectly black or opake.

FRANCES.

And you have not a blue one?

MRS. L.

I have one with a faint tinge. I never saw any deep-blue diamonds, except a small one that was in the collection of the late Mr. Greville\*, and the large one purchased by the king from Mr. Eliason, which you have probably heard of.

MARY.

Yes; I have been told it is worth 30,000*l*.

MRS. L.

Probably it is: diamonds of such uncommon size and rarity of colour cannot be valued by the rules which apply to common cases. The large diamond in the sceptre of the emperor of Russia was purchased by the Empress Catherine, for

\* Before this collection was purchased by the British Museum most of the cut precious stones were disposed of.

about 90,000*l.* ready money, and an annuity of 4,000*l.* more.

FRANCES.

What a sum of money for a little stone! for I suppose it is not very large, except as a precious stone?

MRS. L.

It is about the size of a pigeon's egg, and weighs 193 carats\*.

But the largest diamond hitherto found is in the possession of the rajah of Mattan, in the island of Borneo, where it was found about 80 years since: it weighs 367 carats. Many years ago, the Governor of Batavia tried to purchase it, and offered in exchange 150,000 dollars, two large brigs of war with their guns and ammunition, and other cannon, with powder and shot. But the rajah refused to part with a jewel to which the Malays attach miraculous powers, and which they imagine to be connected with the fate of the royal family.

MARY.

I never heard of this diamond before†;—is it cut?

MRS. L.

I believe not; it is described as having the shape

\* A carat is equal to three grains and two fifths troy weight.

† It is mentioned in the Memoirs of the Batavian Society.



of an egg, with an indentation near the smaller end. The art of cutting and polishing was unknown in Europe till the fifteenth century : before that time rough ones were set as ornaments. Among the diamonds in the British Museum there is a very ancient gold ring (I believe, Roman), in which an octahedral diamond is set; and the four diamonds which ornament the clasp of Charlemagne's mantle are natural crystals. This clasp is still preserved in Paris.

FRANCES.

I suppose they were valued for their rarity formerly ; I remember the ring, and do not think it a very elegant ornament.

MRS. L.

It is probable that they were valued on account of their hardness also, which you know is far greater than that of any other substance ; for this reason, though it is expensive, it is considered as more economical than emery, or any thing else, for cutting and polishing hard stones.

FRANCES.

Are diamonds used for any other purposes ?

MRS. L.

Yes, a great many are employed by the glaziers, who cut out glass with them for window panes : they are set in a steel socket, and attached to a wooden handle about the size of a thick pencil. It

is very remarkable that they can use the point of a natural crystal only, for this purpose : cut or split diamonds will not cut glass properly ; they scratch it, but the glass will not break along the scratch, as it does when a natural crystal is used.

An application of the diamond, of great importance in the art of engraving, has been also made within a few years by the late Mr. Lowry, the first inventor of the mechanical methods now used in that part of the process called etching.

MARY.

In what way could they be made useful ?

MRS. L.

For drawing or ruling lines, afterwards to be deepened by aqua-fortis. Formerly steel points were used for this purpose ; but they so soon become blunt by the friction against the copper, that it has always been impracticable to make what are called flat or even tints with them,—such as the azure part of skies, large architectural subjects, and the sea in maps. But the diamond being turned to a conical point, or otherwise cut to a proper form, is not worn away by the friction of the copper ; and, consequently, the lines drawn by it are all of equal thickness.

FRANCES.

That appears to me a very great improvement ;

but I suppose it is very difficult to turn the diamonds for this purpose?

MRS. L.

There are very few persons who understand well how to make diamond points. They are turned in a lathe, by holding against them a thin splinter of diamond as a chisel.

MARY.

And are not diamonds sometimes used in the works of watches?

MRS. L.

Yes.

FRANCES.

But will you tell me how diamonds were first discovered to be carbon?

MRS. L.

Yes; but when I first mentioned it to you, I should have found it difficult to make you understand me. When a diamond is exposed to a heat rather less than is necessary to melt silver, it is gradually dissipated; and it is found to combine in the same proportion with the oxygen of the atmosphere, as charcoal, when it is burnt. This experiment has been frequently repeated, and always with the same result. It was conjectured to be an inflammable substance as long ago as in 1609\*; and in 1694 and the following year some were

\* Boetius de Boot.

burnt in the presence of the grand duke of Tuscany, by means of a strong lens or burning-glass. Sir Isaac Newton does not appear to have been acquainted with these experiments, but he suspected that it might be combustile, from its very great refracting power.

MARY.

Why so?

MRS. L.

Because it is, in this respect, very analogous to amber; which, as well as other vegetable resins, is highly inflammable. Dr. Brewster has confirmed the relation, which Sir Isaac Newton supposed to exist, between the refractive power and inflammability of substances, by his experiments on phosphorus and sulphur; and his investigation of the properties of the diamond have led him to conclude, “that it has originated, like amber, from, perhaps, vegetable matter, which gradually acquires a crystalline form by the influence of time, and the slow action of corpuscular forces.”\*

The specific gravity of the diamond is not quite 3.5†.

MARY.

Is it true that diamonds will shine in the dark?

\* Edinburgh Philosophical Journal, vol. iii. p. 98.

† Some authors have given it a specific gravity as high as 3.55, and 3.6; their error should, probably, be ascribed to the want of a sufficiently correct instrument.

MRS. L.

I do not know: I have never met with any that have that phosphorescent property. There are many substances prepared artificially which will absorb the sun's rays when exposed to them, and afterwards emit light when in a dark place; and it has frequently been affirmed that diamonds have the same power.

You may observe that all these diamonds are detached, and crystallized on every side.

FRANCES.

Yes; have you none in the rock in which they are found?

MRS. L.

No; they are generally found loose in the beds of streams. A diamond imbedded in the coarse conglomerate which occurs in the diamond district of Golconda is a very rare specimen: I have seen one, which is in the fine collection of Mr. Heuland, and there are two or three more in England. The conglomerate consists of quartz pebbles and ochry earth. You will find an excellent account of the method of seeking diamonds in Mr. Mawe's Travels in the Brazils: it is a very entertaining work, and particularly interesting, as Mr. Mawe is, I believe, the only Englishman who has been permitted to see the Brazilian diamond mines, or (consequently) able to give a correct account of them.

No other minerals are arranged in the same

family with the diamond; but the next contains three substances which consist principally of carbon.

MARY.

This is exactly like a piece of charcoal.

MRS. L.

It is called mineral charcoal, and has the same properties as that obtained by burning wood. It is found in thin layers, between the strata or beds of different kinds of coal, but not abundantly. Graphite, or plumbago, you have seen.

FRANCES.

Yes, in pencils. But why is it called black lead?

MRS. L.

Most probably because plummets, which are thin cylinders of lead, were originally used for drawing on paper; and when this substance was applied to the same purpose, and was found to leave a much darker trace, it was distinguished by that circumstance, without any regard being paid to the difference of its composition. It occurs naturally, in large roundish masses, imbedded in different kinds of rock. The most extensive plumbago mine in the world is, at present, that at Borrodale in Cumberland.

MARY.

Is it useful for any thing besides making pencils?



MRS. L.

Yes; crucibles and furnaces for chemical operations are made of it, which resist a great degree of heat; and, in a state of powder, it is used for brightening grates and for diminishing the friction of machinery.

FRANCES.

It has quite a metallic lustre.

MRS. L.

Yes; particularly the scaly variety. Anthracite differs from it a good deal in external appearance, but the lustre is semi-metallic.

MARY.

Yes; but the fracture of this is conchoidal, while that of graphite is granular and uneven: this is full of cracks, and looks as if it would fall to pieces.

MRS. L.

Sometimes it is slaty, and more seldom columnar. Its specific gravity is between 1.4 and 1.8; that of graphite is about 2.

FRANCES.

What is the difference between this and the coal we generally burn?

MRS. L.

The coal we are accustomed to use, contains between 30 and 40 per cent of bituminous matter, which produces the peculiar odour you smell when it is burnt. But anthracite (or glance coal) burns,

like charcoal, without a flame, and with scarcely any smell ; and, on this account, it is called blind coal in some parts of Scotland.—The next family is much more extensive ; it includes all those minerals which contain, *essentially*, a considerable portion of bitumen, and the mineral oils.

MARY.

Mineral oils ! What are they like ?

MRS. L.

There are two kinds, naphtha and petroleum : I have them both in phials.

FRANCES.

Which is this yellowish limpid fluid ?

MRS. L.

That is naphtha ;—smell it.

FRANCES.

It has rather a pleasant smell.

MARY.

And not like any thing else, I think.

MRS. L.

There is a liquid distilled from coal, and used for lighting a part of the lamps in London, which scarcely differs in any degree from naphtha.

FRANCES.

How is this found, Mrs. L. ; in streams, or pits, or wells ?

MRS. L.

Generally oozing from the rocks, or floating on the surface of streams of water. In Persia, on the border of the Caspian Sea, there are districts where the soil is so impregnated with naphtha, that if a few inches of the surface be scraped off, and a light applied, it takes fire immediately, and can be extinguished only by preventing the access of air. The ancient Persians, who were fire-worshippers, considered it as sacred fire, and built temples where it issued from the ground, and kept it constantly burning.

MARY.

Are any of those temples in existence now ?

MRS. L.

Yes ; there is a large one at Badku, or rather a collection of many small cells, surrounding an open area, each of which is inhabited by a priest, who watches over the fire : about a mile and a half distant there are wells from which naphtha is collected ; and sometimes it rises to the surface of the earth, takes fire spontaneously, and flows, like a blazing torrent, to a great distance over the Caspian Sea.

FRANCES.

It must be a magnificent sight ; but, I suppose, almost as destructive as the eruption of a volcano ?

MRS. L.

No ; the naphtha, when burning in the open air,

is dissipated so fast, that the flame has very little heat: but when it is lighted by means of a tube (such as a piece of a reed) inserted in the ground, it is sufficiently hot for culinary purposes. It is found also in Japan and many European nations. In Japan and Italy the lamps are lighted with naphtha.

Petroleum, sometimes called black naphtha, occurs in different parts of England, particularly in Shropshire, where it issues from a limestone rock.

MARY.

What is the difference between this and naphtha?

MRS. L.

It appears to be a mixture of naphtha with bitumen, which renders it more viscid than the other kind. It is generally found where coal is abundant. In the kingdom of Ava there is a stratum of coal which yields an immense quantity of petroleum. At Rangoon, and about four or five miles distant, above five hundred small pits, or shafts, are sunk through earth, sandstone, and clay, till they reach the coal: through these shafts it is drawn up in jars; and as soon as one is exhausted, they sink another.

FRANCES.

Is it used for the same purposes as the naphtha?

MRS. L.

No; it is too thick for burning in lamps: it is

mixed with sand or earth, and made into cakes for fuel; but its principal use is to supply the place of tar, in covering boats and the roofs of houses.\* The petroleum of Rangoon is of a greenish colour; that of Shropshire is blackish-brown.

Of bitumen, or mineral pitch, there are three varieties: this is quite soft and elastic.

MARY.

So it is; it is like Indian rubber, when it has been made warm.

MRS. L.

It is curious that it will take up a pencil-mark in the manner of Indian rubber; but it leaves a soil itself upon the paper.

FRANCES.

Are the little black globules on this specimen the same substance?

MRS. L.

Yes; that is a petrified shell from Derbyshire, and the bitumen is supposed to be produced from the animal that once inhabited it. The harder kind of bitumen is called asphaltum, a name derived from the lake Asphaltites in Judea (now the Dead Sea), where it is found in abundance floating on the surface. The fracture of this kind is

\* For a more particular account of these pits, see Edinburgh Philosophical Journal, vol. v. p. 27., or Symes's Embassy to Ava.

perfect and large conchoidal, and the lustre resinous.

MARY.

Will these minerals burn in the candle?

MRS. L.

Yes, readily;—you may try this one.

MARY.

O, yes; how bright the flame is!

FRANCES.

The heat seems to melt it.

MRS. L.

Yes, it melts quickly when exposed to heat; and the ancients employed it in a liquid state instead of mortar. The bricks of the walls of Babylon were cemented with hot bitumen.

MARY.

And is it of any use in England?

MRS. L.

Yes; a great quantity is used for making the black varnish, commonly called japan.

Bitumen, when much intermixed with earthy matter, was formerly called maltha; sometimes it contains so much earth or sand as to be rather heavy. The specific gravity of it depends on its purity; that of asphaltum varies from rather less than 1 to 1.6. Petroleum by exposure to the air thickens and becomes like bitumen.



FRANCES.

These are very curious substances. I had no idea there were such things in nature :—are the minerals in the next drawer coal ?

MRS. L.

Yes ; there are many varieties of it, but the principal divisions are black and brown coal.

MARY.

That we commonly use is black coal, I suppose ?

MRS. L.

Yes ; it is also called slate coal, from its structure : you know it splits much more readily in one direction than any other.

FRANCES.

Yes ; I have remarked that when the coal begins to be warm, a very slight force will split it.

MRS. L.

I dare say you have often seen pyrites in the coal ; it is the cause of most of the explosions you so frequently hear in the fire.

FRANCES.

O, yes ! and I have been told by persons, who certainly believed it themselves, that it is gold.

MRS. L.

Gold has never been found in coal-mines, and I think it is pretty certain that it never will be found in such a situation. Here is a specimen of common

coal, with beautiful iridescent colours on the surface.

MARY.

That is a very pretty specimen, but I suppose it is a rare variety?

MRS. L.

No; I dare say, if you like to take the trouble of mineralizing in the coal cellar, you may find some similar pieces.

FRANCES.

Is not this jet, Mrs. L.?

MRS. L.

No, it is cannel coal; called, in some parts of Scotland, parret coal.

MARY.

How very compact it is; and it does not soil my fingers, as the common coal does.

MRS. L.

No; it resembles jet very much; but the fracture has less lustre, and the colour is not so perfectly black. As it takes a pretty good polish, snuff-boxes and ink-stands, and even necklaces, are often made of it; but jet is much more extensively used for ornamental purposes. In the district of Aude in France, twelve hundred men are employed in turning and cutting jet into buttons, necklaces, ear-rings, rosaries, and drinking-vessels. It is said

that about 100,000 weight of it is yearly expended for these purposes.

FRANCES.

Is it possible so much can be used every year?

MRS. L.

Perhaps so; a great part of it is exported to Spain.—Jet is found in considerable abundance in the Prussian amber-mines, and the miners call it black amber; sometimes pieces of amber are found inclosed in it. There are a few other carbonaceous minerals occasionally found in beds of coal, which are considered as varieties of black coal; but they are of very little consequence. One kind is called, from its texture, soot coal.

MARY.

Is this it?

MRS. L.

Yes; it is quite earthy in some parts, and soils very strongly. The coal used in London is brought chiefly from Newcastle, but great quantities are raised in other parts of England. The same bed which is worked at Newcastle extends through Durham, Yorkshire, and Derbyshire, and terminates in Nottinghamshire. Great abundance of coal is found at Whitehaven in Cumberland; and again, in the Forest of Dean in Gloucestershire, and in Shropshire, besides other detached patches of coal in different counties. These are technically termed coal-fields.

FRANCES.

Is the coal obtained always by means of pits ?  
or are there mountains of coal ?

MRS. L.

No ; there are no mountains of coal : the beds, or strata, are thin, in comparison with those which occur between and above them. The coal-field of Northumberland consists of a series of beds, amounting to two hundred and twenty-nine.

MARY.

What an expense it must be to work through so much useless stone !

MRS. L.

It is not *all* useless ; some of the sandstones are applied to different purposes.

FRANCES.

But is not coal found in other countries ?

MRS. L.

Yes ; it is plentiful in many parts of Germany, in France, and in North America ; but it is more extensively used in England than in any other country, because we have now no forests to supply us with wood at a smaller expense.

Brown coal is bituminized wood, and several varieties are found in England.

MARY.

This, I suppose, you call fibrous ; it shows the woody structure remarkably well.

MRS. L.

Yes; that is from Bovey Tracy, in Devonshire, where also the conchoidal variety is found: they differ only in their degree of compactness.

FRANCES.

And are they used for fuel?

MRS. L.

Yes; they answer very well where a great heat is not required: they burn with a clear flame and bituminous smell, quite different from that of black coal, and, I think, much pleasanter. A great deal of the fibrous kind is found in Iceland, where it is called *surturbrand*. Formerly whole trees were dug up impregnated with bitumen, of which the Icelanders made tables and such furniture as did not consist of small parts. Another mineral, having the properties of bituminous wood, but of a coarse texture and nearly black, is sometimes found in beds of the fibrous kind, particularly in Bohemia; it is called *moor-coal*.

MARY.

Is not the *mellite* found on a substance like this?

MRS. L.

Yes, and amber sometimes; but that belongs to the next family, which contains mineral resins. Amber is a substance you have often seen.

FRANCES.

Yes; but not any like this.

MRS. L.

The transparent yellow amber is the most admired, and therefore the most used. But the opaque variety, of a yellowish-white colour, is not uncommon. Sometimes the colour approaches to hyacinth-red.

MARY.

Have you no specimens of amber containing insects?

MRS. L.

No: it is a common belief that amber frequently contains insects; but the fact is, that all those specimens inclosing insects, which are sold under the name of amber, are a kind of gum, which is easily dissolved, or softened, in many liquids; and the insects are introduced before it becomes hard again.

FRANCES.

But is not amber a kind of gum?

MRS. L.

It is probable, for many reasons, that it had a vegetable origin; but it is never found adhering to, or exuding from, living trees, in the manner of other gums.

The Prussian amber-mines are worked in a stratum of trees, partly decomposed and impregnated with pyrites, partly converted into jet and amber; and stalactites of amber are sometimes found depending from the branches. I mentioned



to you that amber, as well as several kinds of gum, was very similar to the diamond in its effects on light.

MARY.

Is amber, then, composed chiefly of carbon.

MRS. L.

Yes; it burns with a bright flame, and a great deal of smoke, which has a pleasant aromatic smell. A mineral resin was discovered, some years ago, in digging Highgate tunnel, which was called fossil copal. Here is a little of it, with some of the blue clay it was imbedded in.

FRANCES.

And will this burn?

MRS. L.

Yes, nearly like amber. It was named from its resemblance to gum copal.

The last species is retin-asphalt, an opaque, resinous mineral, which occurs in the bituminous wood at Bovey Tracy.

MARY.

It is very light, but it has not much resemblance to resin.

MRS. L.

It appears, by analysis, to consist of a mixture of resin and asphaltum, with about 3 per cent of earthy matter. It is found adhering to the brown coal, in irregular lumps, generally of a light-brown

colour; the fracture is imperfectly conchoidal, without any lustre. All the minerals of this family may be easily known by their aromatic smell when burnt, and their very low specific gravity, which is scarcely more than that of water.

FRANCES.

Are they, like amber, rendered electric by friction?

MRS. L.

I have never been able to render any of these specimens of resin-asphalt or fossil copal electric by friction; the white amber is very weakly so, and, in some pieces this property cannot be excited at all; particularly this kind, which is quite opaque, and not unlike meerschaum. These are specimens of native sulphur.

MARY.

I had no idea that sulphur was ever so transparent: these crystals are beautiful.

MRS. L.

They are from Spain: there are extensive mines of sulphur in Murcia and Arragon. The primitive crystal is an acute octahedron, of which the base is a rhombus. (fig. 398.)

FRANCES.

There are some small primitive crystals in the hollows of this specimen.

MARY.

I see several modifications in these; some have

their opposite edges truncated, and others the summits. (figs. 400, 401, 402.)

MRS. L.

The colour is always the same; but some crystals are less transparent than others: the fracture is imperfectly conchoidal and shining, or even splendid; the surface of the crystals is generally bright. When they are rubbed, they become, like amber, negatively electric.

FRANCES.

Is sulphur found in any part of England?

MRS. L.

No; but it occurs in Iceland, France, Switzerland, Transylvania, and Poland.

The other kind of sulphur is found only in volcanic countries.

MARY.

Is it very different, in its appearance, from native sulphur?

MRS. L.

Yes; it generally has a cellular or corroded appearance, or forms thin crusts on lava. This is a specimen from Solfaterra, where there is an immense deposit of it, from which it is collected for commercial purposes.

FRANCES.

Is it never crystallized?

MRS. L.

Sometimes you may observe tufts of crystals, but they are very minute. The colour of volcanic sulphur is frequently deep orange, and sometimes red, which is never the case with the other kind; and it is translucent or nearly opaque. The crystallized sulphur refracts doubly, and is sometimes quite transparent.

This mineral, and those of the last two families, are considered to be of much more recent origin than the earthy substances of which the crust of the earth is chiefly composed, or the metallic ones that are found imbedded in them. Indeed, the formation of sulphur is still taking place in most volcanic countries. But the consideration of the different ages of minerals belongs to geology.

MARY.

I should be delighted to know something of it; for I have found mineralogy extremely entertaining; and I think geology cannot be less so.

MRS. L.

It is a very interesting study; but it cannot be pursued in the limited way in which a knowledge of mineralogy may be acquired,—I mean by examining cabinet-specimens. An acquaintance with its principal features may be obtained from books; but in order to become a geologist, you must not only observe the different rocks and strata in various countries, but must also carefully compare those of

the same kind occurring in different situations, or you will not be able to derive much advantage from books.

FRANCES.

Do you think it would be of any use to me, if I were to write some account of all the minerals and rocks which I shall see in my excursion into Cornwall?

MRS. L.

I would advise you, my dear, to confine yourself at present to the examination of *simple minerals*, such as I have shown you. Many of the rocks are compounded of two, three, or even more, of these substances; and you do not know even their names. Yet, if you are anxious to study geology, you may find a great deal of useful information in Mr. Phillips's "Outlines of the Geology of England and Wales." That work is an excellent and well arranged collection of geological facts: and Cuvier's "Introduction to the Theory of the Earth," though it may be styled an elementary one, is truly scientific. To read either of these carefully will, during your travels, sufficiently occupy your leisure; and if, on your return, you feel inclined to pursue the study of geology, I will endeavour to assist you. I can lay before you an extensive collection of rock-specimens; and if you set any value on my instructions, those instructions shall be cheerfully imparted.





# APPENDIX, No. I.

---

## DERIVATION

OF THE

NAMES OF SEVERAL MINERAL SUBSTANCES.

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**ACTINOTE**, or *Actinolite*—*ακτιν* (actin), a ray, and *λιθος* (lithos) a stone\*: a radiated mineral.

**ADULARIA**—the mountain called Adula, on which it is supposed to have been first observed.

**AGALMATOLITE**—*αγαλμα* (agalma), a statue; because figures are carved in it.

**AGARIC** mineral—the resemblance to a fungus, or agaric.

**AGATE**—the river Achates, in Sicily, where it was first found.

**ALABASTER**—*αλαβαστρον* (alabastrōn), a kind of marble of which vases were made.

**ALALITE**—town of Ala, in the Alps, near which it was discovered.

**ALLOCHROITE**—*αλλος* (allōs), different, and *χρῶα* (chrōa), colour: it changes its colour before the blowpipe.

**ALLOPHANE**—*αλλος* (allōs), different, and *εφανη* (ēphanē), it appears; 2d aorist passive of *φαινω* (phainō). It resembles another mineral,—carbonate of copper.

**AMETHYST**—*αμεθυστος*, from *α* privative, not, and *μεθυσθη* (methūsthē), he may be made drunk; 3d pers. sing. 1st aor.

\* In order to avoid frequent repetitions, it may here be observed, that all the terminations in *lite* are derived from the Greek *lithos*; the *l* is frequently dropped; and those in *ite* have the same origin.

pass. v. *μεθυσω*; because it was supposed to be an antidote to intoxication by being worn.

AMIANTH—*αμιαντος* (amiantos), unstained or undestroyed.

AMPHIGENE—*αμφι* (amphi), about, and *γενος* (gēnōs) origin: from the doubtfulness of its primitive (or original) form, which may be either a cube or an octahedron.

ANALCIME—*α*, not, and *αλκιμος* (alkimos), powerful: it is very weakly electric. The *ν* (n) is added for the sake of sound.

ANATASE—*ανα* (ana), up, in height, and *τασις* (tasis), length, extension; from the form of its crystals, a long, or acute octahedron.

ANDALUSITE—from Andalusia, where it was first discovered.

ANHYDRITE—*α* privative, and *υδωρ* (hūdōr), water or moisture; a mineral which contains no water. Other substances are called anhydrous for this reason.

ANTHOPHYLLITE—from the resemblance of its colour to that of the anthophyllum, a flower.

ANTHRACITE—*ανθραξ* (anthrax), a coal.

APATITE—*απαταω* (apataō), to deceive; because it resembles several minerals so much as to be sometimes mistaken for them.

APHRITE—*αφρος* (aphros), froth.

APLOME—*απλοος* (haplōos), simple, underived; because the primitive is uncertain.

APOPHYLLITE—*απο* (apo), from, and *φυλλον* (phūllon), a leaf; from its foliated structure.

ARCTICITE—first found within the Arctic circle.

ARENDAHLITE—Arendahl in Norway.

ARRAGONITE—Arragon, in Spain.

ASBESTUS—*α* not, and *σβεννυμι* (sbennumi), to extinguish. It cannot be burnt; and the ancients are supposed to have made the wicks of lamps of it.

ASPHALT—from the lake Asphaltites.

AVANTURINE.—This name was first given to a glittering substance, by a French workman, who dropped some brass or

copper filings into a vitreous mixture in a state of fusion, *par aventure*. Mineralogists afterwards applied it to the variety of quartz, which resembles it.

AUGITE—*αυγη* (augē), splendour.

BARYTES—*βαρυς* (barūs), heavy.

BLENDE—from the German *blenden*, to dazzle or blind the eyes, when held in the sunshine ; glistening.

BOTRYOLITE—*βοτρυς* (botrūs), a cluster of grapes.

BROOKITE—in honour of Mr. Brooke.

CALAMINE—Lat. *calamus*, a reed ; because, when it is melted, it adheres to the bars of the furnace in the form of reeds.

CALCEDONY (more properly *Chalcedony*)—from *χαλκηδών* (chalkēdōn), a city of Bithynia, in Asia Minor.

CARNELIAN—*carne*, the ablative case of *caro* (Lat.), flesh ; from its colour.

CERITE—planet Ceres.

CEYLONITE—Ceylon, whence it was first brought.

CHIASTOLITE—from its having the mark of the Greek letter chi (X).

CHLORITE—*χλωρος* (chlōros), green.

CHLOROPHANE—*χλωρος* (chlōros), green, and *εφανη* (ēphanē), it appears : it acquires this colour by being heated.

CHROME—*χρωμα* (chrōma), colour : it received this name from its imparting colour to the minerals which contain it.

CIMOLITE—the Isle of Cimolia, now Argentiera.

CINNABAR—*κινναβαρι* (kinnabari), red-coloured grain.

COCCOLITE—*κοκκος* (kokkōs), a grain ; from its structure.

COLOPHONITE—from its resemblance to resin, anciently called *colophonix pix*, from the city of Colophon, in Asia Minor.

CRYOLITE—*κρυος* (kruōs), cold : it melts like ice, in the flame of a candle.

CYANITE—*κυανος* (kuanos), blue colour.

DATHOLITE—*δαθολος* (datholos), turbid : the crystals are never transparent.

DIALLAGE—*διαλλαγη* (diallagē), difference. Haiüy gave it

this name from the difference of cleavage in this mineral and in others that were often confounded with it.

**DIASPORE**—*διασπορα* (diaspora), dispersion ; when it is exposed to the flame of a candle, it flies into minute splinters and is dispersed.

**DICHOITE**—*δισ* (dis), twice, and *χροα* (chrōa), colour ; on account of the two colours it exhibits when viewed in different directions.

**DIOPSIDE**—*διοψις* (diopsis), a looking or seeing through ; signifying that the mineral is transparent. All the other varieties of augite are opaque, or nearly so.

**DIOPTASE**—*διοπτασις* (diopťasis), visible on looking through it ; that is, the planes of cleavage, from the light they reflect.

**DIPYRE**—*δισ* (dis), twice, and *πυρ* (pūr), fire ; from the double effect of fire on it. This mineral melts and phosphoresces at the same time before the blowpipe.

**DISTHENE**—*δισ* (dis), double, and *σθενος* (sthenos), force : it acquires both kinds of electricity by friction.

**DOLOMITE**—M. Dolomieu, a celebrated geologist.

**ELAOLITE**—*ελαιον* (elaion), oil ; from its oily lustre.

**ELECTRUM**—the Latin name for the same mixture of gold and silver.

**EPIDOTE**—*επιδοσις* (epidōsis), an addition. Haiüy, who gave it this name, alluded to the form of the base of the prism ; two sides being longer than the other two, the base seems to have received an *enlargement* in one direction.

**EUCLASE**—*ευ* (eu), easily, and *κλασις* (klasis), breaking ; from its great frangibility.

**EUDYALITE**—*ευ* (eu), easily, and *δυνω* (duō), to vanish ; from its dissolving easily in acids.

**EUKAIRITE**—*ευ* (eu), fortunately, and *καιρος* (kairos), an occasion ; named by Berzelius, from its fortunately coming to his knowledge at the time he was finishing his investigation of the properties of selenium, a metal which it contains.

FELSPAR (properly *Feldspar*)—derived from the German *feld* (a field), and *spath* (spar), a shining substance; in German *feldspath*, from its so frequently being a constituent of the loose blocks of stone (*feldern*) scattered over the country.

FLUOR—Lat. *fluo* (to flow): it was first used in Germany as a flux to reduce the metallic ores.

GADOLINITE—Professor Gadolin, who analysed it.

GARNET—Lat. *granum* (a seed): the seed of the pomegranate, from its colour.

GLUCINE—*γλυκὺς* (*glucūs*), sweet: when dissolved in acids, it forms sweet salts.

GRAMMATITE—*γραμμα* (*gramma*), writing, marked by a line; in reference to its crystals.

GRAPHITE—*γραφω* (*graphō*), to draw. It is well known under the name of black-lead.

GRENATITE—from its resemblance to garnet. (See GARNET.)

GROSSULAR—*groseille* (Fr.), a gooseberry; from its colour.

GURHOFITE—so called from Gurhof, in Austria.

GYPSUM—*γυψω* (*gūpsōō*), to plaster or spread. From this mineral, plaster of Paris is manufactured.

HÆMATITE—*αἷμα* (*haima*), blood; from its colour.

HARMOTOME—*ἄρμος* (*harmos*), a joining or fitting together, and *τετομμε* (*tětōmĕ*), 3d pers. sing. perf. mid. of *τεμνω*, to cut; from the peculiar form of its crystals.

HAÜYNE—L'Abbé Haiüy.

HELIOTROPE—*ἥλιος* (*hēlios*), the sun, and *τροπή* (*trōpē*), a turning. According to Pliny, it was used for solar observations.

HELVINE—*ἥλιος* (*hēlios*), the sun; from its yellow colour.

HUMBOLDTITE—in honour of Baron de Humboldt.

HYALITE—*ὑαλός* (*hualōs*), glass; from its glassy appearance.

HYDROPHANE—*ὑδωρ* (*hūdōr*), water, and *εφανη* (*ēphanē*), it

shines. By immersion in water, it acquires the property of reflecting brilliant colours.

**HYPERSTHENE**—*ὑπερ* (huper), above, and *σθενος* (sthènos), strength; from its remarkable tenacity.

**ICHTHYOPHTHALMITE**—*ιχθυς* (ichthūs), a fish, and *οφθαλμος* (ophthalmos), an eye; the lustre of this mineral resembling that of a fish's eye.

**IDOCRASE**—*ειδος* (eidos), a form, and *κρασις* (krāsis), a mixture; a mixed form.

**INDIANITE**—India; at present, its only locality.

**INDICOLITE**—so called from its indigo-blue colour.

**IOLITE**—*ιον* (ion), a violet; from its colour.

**IRIDIUM**—*iridis*, gen. case of *iris* (Lat.), the rainbow; from the variety of colours which its solutions exhibit.

**ISERINE**—river Iser, near the Riesengebirge.

**JASPER**—*ιασπις* (iaspis).

**JENITE**—Jena.

**KARPHOLITE**—*καρφος* (karpfos), straw; from its colour.

**KOUPHOLITE**—*κουφος* (koupfos), light; from its specific gravity being less than that of other varieties of the same species.

**KYANITE**—*κυανος* (kuanos), a blue colour.

**LATIALITE**—Latium, where it was first found.

**LAUMONITE**—from Gillet Laumon, its discoverer.

**LEPIDOLITE**—*λεπις* (lēpīs), a scale, and *λίθος* (lithos), a stone; from its structure.

**LEUCITE**—*λευκος* (leukos), white.

**LIEVRITE**—Le Lièvre, a mineralogist.

**LITHOMARGE**—*λιθος* (lithos), a stone, and *marga* (Lat.), marl.

**LUCULLITE**—black marble; which, according to Pliny, was named by the consul Lucullus, after himself.

**MALACHITE**—*μαλαχη* (malachē), marsh-mallow; from the resemblance of their colour.

**MEERSCHAUM**—*meer*, the sea, and *schaum*, froth, (Germ.) sea-foam.



MEIONITE—*μειων* (meiōn), inferior; from the lowness of its pyramid, compared with that of other crystals.

MELANITE—*μελας* (mēlas), black.

MELLITE—*mel* (Lat.), honey; from its colour.

MENACCANITE—valley of Menaccan, in Cornwall.

MENILITE—Menil Montant, near Paris.

MESOLITE—*μεσος* (mēsōs), middle, or intermediate: it is intermediate between natrolite and skolezite.

MESOTYPE—*μεσος* (mēsōs), middle, and *τυπος* (tūpos), a mark or form. Haiiy considered its primitive form as being intermediate between those of analcime and stilbite.

MICA—*mico* (Lat.), to glitter.

MIEMITE—Miemo, in Tuscany.

NACRITE—*nacré* (Fr.), pearly.

NAPHTHA—*ναφθα* (naphtha), from *αναφθη* (anaphthē), it may be set on fire, 3d pers. sing. 1st aor. subj. of *αναπτω*.

NATROLITE—from natron, which it contains.

NATRON—desert of Nitron, where it was anciently collected.

NEPHELINE—*νεφελη* (něphlē), a cloud: it is not quite transparent.

NICKEL—(Germ.) false. The first ore of nickel that was discovered, was thought to be copper ore; but as that metal could not be extracted from it, the miners called it *kupfer-nickel*, which means “false copper:” and Hierne, who first ascertained its nature, gave it this name.

NIGRINE—*nigri*, gen. case of *niger* (Lat.), black.

NOVACULITE—a whetstone; from *novacula* (Lat.), a knife.

OBSIDIAN—Pliny gave this name to a black glassy mineral which was found in Æthiopia by Obsidius.

OCTAHEDRITE—*οκτω* (oktō), eight, and *εδρα* (hēdra), a side; from its form, an octahedron.

OLIVINE—of an olive colour.

ONYX—ονυξ (önux), a nail. It is described by the ancients as having the form and colour of the white part of the nail.

OÖLITE—ωον (oön), an egg. Its resemblance to the hard roe of a fish is striking.

OPAL—ωψ (ōps), an eye: it was believed by the ancients to have the power of strengthening the eye.

ORPIMENT—*auri pigmentum* (Lat.), gold paint; from its colour.

ORTHITE—ορθος (orthōs), right or straight; because it has been observed always to form very straight veins.

PALLADIUM—*Palladis*, gen. case of *Pallas* one of the planets.

PARANTHINE—παρανθει (paranthei), it decays: 3d pers. sing. pres. indic. of παρανθειω, to decay as a flower; *i. e.* by exposure to the air.

PELIOM—πελιωμα (peliōma), blackish-blue colour.

PETROLEUM—πετρα (pētra), a rock, and *oleum* (Lat.), oil; mineral oil.

PICROLITE—πικρος (pikros), bitter.

PIMELITE—πιμελη (pimelē), fat; it has a greasy feel.

PINITE—Pini gallery in the mines of Schneeberg.

PISTACITE—πιστακια (pistakia), the pistachio nut; from its colour.

PLASMA—πλασμα (plasma), a work, or workmanship; the ancients engraved on it heads and other subjects.

PLATINA—*plata* (Spanish), silver, a diminutive noun; probably from its occurring in small grains.

PLEONASTE—πλεοναστος (plēonastōs), abounding. Häüy gave it this name, from the number of faces on some of the crystals, in which it principally differs from spinelle.

PLUMBAGO—*plumbus* (Lat.), lead, and *ago*, to act; because it supplies the place of lead in drawing.

POLYHALLITE—πολυς (pōlus), many, ἅλς (hals), salt. It is a combination of several salts.

PRASE—πρασον (prasōn), a leek; from its colour.

PREHNITE—Prehn, who discovered it.

PUMICE—(Lat.) *pumex*.

PYCNITE—*πυκνος* (pūknōs), compact.

PYRITES—*πυρ* (pūr), fire, or *πυριτις* (puritis), the stone itself, which emits sparks when struck.

PYROPE—*πυρ* (pūr) fire, *ωψ* (ōps), appearance.

PYROPHYSALITE—*πυρ* (pūr), fire, and *φυσαι* (phusao), to swell or bubble; from the effect of the blowpipe on it.

PYRORTHITE—*πυρ* (pūr), fire, and Orthite (which see). This mineral is combustible in a great heat.

PYROSMALITE—*πυρ* (pūr), fire, and *οσμη* (osmē), odour; in allusion to the smell it emits when heated.

PYROXENE—*πυρ* (pūr), fire, and *ξενος* (xēnōs), a stranger; because, though it is found in lava, it has been thought not to be a volcanic production.

RUBY—*ruber*, or *rubicus* (Lat.), red; from its colour.

RUTILE—*rutilus* (Lat.), red.

SAHLITE—Sahla, in Sweden, where it was found.

SAPPHIRE—*σαπφειρος* (sappheiros); its ancient name.

SAUSSURITE—so named from Saussure, the geologist.

SCAPOLITE—*σκαπτου* (skapton), a rod; from the form of its crystals.

SCHEELE, or Scheelium.—Werner gave this name to Tungsten, in honour of Scheele, who discovered the metal it contained.

SCHILLERSPAR—*schillern* (Germ.), to reflect a chatoyant light.

SCHORL—so called from the village of Schorlau.

SELENITE—*σεληνη* (sēlēnē), the moon; from its silvery appearance.

SELENIUM—(idem); indicating its relation to tellurium (which see).

SERPENTINE—from its resemblance to the skin of a serpent, in colour and delineations.

SKOLEZITE—σκοληξ (skōlēx), a worm; in allusion to its twisting or curling when subjected to the action of heat.

SKORODITE—σκοροδον (skōrōdōn), garlic; in allusion to the smell it emits when acted on by the blowpipe.

SLICKENSIDE, or Sleek-inside—from its polished surface.

SMARAGDITE—*smaragdus* (Lat.), an emerald; from its colour.

SOMMITE—so called from Monte Somma.

SPHENE—σφην (sphēn), a wedge; in reference to the form of its crystals.

SPHEROSIDERITE—*sphæra* (Lat.), a sphere, and *siderites* (Lat.) an ironstone.

SPODUMEN—σποδος (spōdōs), ashes, and μενω (mēnō), to remain. By the action of the blowpipe it is converted into scales, and afterwards into ashes.

STALACTITE—σταλακτις (stalaktis), a dropping or trickling, as of water; a stone formed by the dropping of water.

STAUROLITE—σταυρος (staurōs), a cross; the crystals intersect each other, like a cross.

STEATITE—στεαρ (stēar), soap; it feels remarkably soapy.

STEINHEILITE—first observed by Count Steinheil.

STILBITE—στιλβος (stilbōs), splendid.

STILPNOSIDERITE—στιλπνος (stilpnos), shining, and σιδηρος (sidēros), iron; an iron ore, having considerable lustre.

STRONTIAN—so called from a village of that name in Scotland.

TELESIE—τελειος (tēlēsiōs), perfect; a name given by Haiüy to sapphire, as being a more perfect or pure corundum.

TELLURIUM—from *telluris*, gen. case of *Tellus* (Lat.), the Earth; other metals having been named after the other planets.

THALLITE—θαλλος (thallōs), the bud of the olive-tree; from its colour.

THOMSONITE—named after Dr. Thomson.

THUMERSTONE—Thum, in Saxony.

TOPAZ—Τοπαζιον (tōpāzōn), an island in the Red Sea, where the ancients collected topazes ; and which was so called from the verb τοπαζω (tōpazō), to seek ; because it was frequently concealed by fog, and difficult to find.

TOURMALINE—probably derived from Tournamal, its Cingalese name.

TREMOLITE—so called from the valley of Tremola.

TRIPHANE—τρις (tris), thrice, and εφανη (ephanē), it appears ; it has three cleavages, equally distinct.

TRIPOLI—from its locality.

TUNGSTEN—this means “ heavy stone ” in the German language ; so called from its great specific gravity.

URANIUM—from the planet Uranus, more commonly called the Herschel or Georgium Sidus.

WAVELLITE—so called from Dr. Wavell, who analysed it.

WERNERITE—D’Andrada named it after the great mineralogist Werner.

WITHERITE—named after Dr. Withering, who discovered this mineral at Anglesark in Lancashire.

WOLFRAM—This mineral was originally mistaken for antimony, which was called *the wolf* by the alchymists. Hence arose the term *spuma lupi* (foam of the wolf), the word *ram* (signifying *spuma*) being applied by the Germans to many substances having a laminated texture.

YENITE—named after the battle of Yena or Jena.

YTTRIA—this substance was first found at Ytterby in Sweden.

ZEOLITE—ζεω (zēō), to froth ; in reference to the action of the blowpipe on it.

ZIRCON—an Indian word, signifying “ four-cornered,” and applied to these crystals.

ZOISITE—named after Baron Von Zois.

# APPENDIX, No. II.

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## TABULAR VIEW

OF THE

ARRANGEMENT ADOPTED IN THIS WORK.

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### EARTHY CLASS.

#### ORDER I.—EARTHY MINERALS.

1st Genus.—(*Siliceous.*)

/ FLINT FAMILY.

1. Quartz.

1. Amethyst.
2. Rock crystal.
3. Common quartz.
4. Fat quartz.
5. Sandstone.
6. Rose quartz.
7. Aventurine.
8. Cat's-eye.
9. Prase.

2. Iron-flint.

3. Hyalite.

4. Opal.

1. Precious opal.
2. Common opal.
3. Semi-opal.
4. Fire opal.
5. Hydrophane.

6. Cacholong.

7. Wood opal.

5. Menilite.

1. Brown.

2. Grey.

6. Siliceous sinter.

1. Common.

2. Opaline.

3. Pearly.

7. Flint.

8. Hornstone.

1. Conchoidal.

2. Splintery.

3. Woodstone.

9. Calcedony.

1. Common.

2. Carnelian.

3. Plasma.

4. Heliotrope.

5. Chrysoprase.



## 10. Jasper.

1. Egyptian.
2. Common.
3. Striped.
4. Porcelain.
5. Agate jasper.

## 11. Agate.

## 12. Flinty slate.

1. Common.
2. Lydian-stone.

## 2 GARNET FAMILY.

## 1. Garnet.

1. Precious.
2. Common.

## 2. Topazolite.

## 3. Pyreneite.

## 4. Grossular.

## 5. Allochroite.

## 6. Colophonite.

## 7. Melanite.

## 8. Pyrope.

## 9. Aplome.

## 10. Leucite.

## 3 IDOCRASE FAMILY.

## 1. Idocrase.

## 2. Cinnamon-stone.

## 3. Gehlenite.

## 4. Scapolite. (Meionite.)

## 1. Radiated.

## 2. Foliated.

## 3. Compact.

## 4 SCHORL FAMILY.

## 1. Schorl.

## 1. Precious(tourmaline).

## 2. Common.

## 2. Iolite.

## 1. Steinheilite.

## 2. Peliom.

## 3. Axinite.

## 5 EPIDOTE FAMILY.

## 1. Epidote.

## 1. Common.

## 2. Manganesian.

## 2. Zoisite.

## 6 PITCHSTONE FAMILY.

## 1. Obsidian.

## 2. Pitchstone.

## 3. Pearlstone.

## 4. Spherulite.

## 5. Pumice.

## 1. Common.

## 2. Glassy.

## 7 ZEOLITE FAMILY.

## 1. Karpholite.

## 2. Prehnite.

## 1. Foliated.

## 2. Radiated.

## 3. Sodalite.

## 4. Natrolite.

## 5. Skolezite.

## 6. Mesolite.

## 7. Thomsonite.

## 8. Stilbite.

## 9. Analcime.

## 10. Chabasite.

## 11. Harmotome.

## 12. Laumonite.

## 13. Dipyre.

## 8 LAZULITE FAMILY.

## 1. Lapis lazuli.

## 2. Haiyne.

## 9 FELSPAR FAMILY.

## 1. Felspar.

## 1. Adularia.

## 2. Glassy felspar.

## 3. Common felspar.

## 4. Compact felspar.

## 5. Disintegrated felspar.

## 2. Labradorite.

## 3. Albite.

## 4. Anorthite.

## 5. Indianite.

## 6. Gieseckite.

## 7. Spodumene.

## 1. Common spodumene.

## 2. Amblygonite.

## 3. Killinite.

## 8. Elaolite.

9. Apophyllite.
10. Petalite.
11. Saussurite.

## MICA FAMILY.

1. Lepidolite.
2. Mica.
3. Pinite.

## SLATE FAMILY.

1. Clay slate.
2. Whet slate.
3. Alum slate.
4. Drawing-slate.
5. Bituminous slate
6. Adhesive slate.

## CLAY FAMILY.

1. Gibbsite.
2. Porcelain clay.
3. Potters' clay.
4. Loam.
5. Claystone.
6. Variegated clay.
7. Slate clay.
8. Rottenstone.
9. Tripoli.
10. Polishing slate.
11. Kollyrite.

## LITHOMARGE FAMILY.

1. Lithomarge.
  1. Indurated.
  2. Friable.
2. Pimelite.
3. Figurestone.
4. Mountain soap.
5. Bole.
6. Yellow earth.
7. Green earth.
8. Fullers' earth.
9. Cimolite.
10. Lemnian earth.

## HORNBLÉNDE FAMILY.

1. Hornblende.
  1. Common.
  2. Basaltic.

3. Slaty.
2. Actinolite.
  1. Granular.
  2. Common.
  3. Glassy.
  4. Asbestous.
3. Tremolite.
  1. Common.
  2. Glassy.
  3. Asbestous.
  4. Compact.
4. Diallage.
  1. Smaragdite.
  2. Schillerspar.
5. Bronzite.
6. Anthophyllite.
7. Hypersthène.

## AUGITE FAMILY.

1. Augite.
  1. Common.
  2. Sahlite.
  3. Coccilite (granular augite).
  4. Pyrgomme.
  5. Diopside.
    1. Alalite.
    2. Mussite.

2d Genus.—(*Magnesian.*)

## MAGNESITE FAMILY.

1. Hydrate of magnesia.
  1. Foliated.
  2. Earthy.

## TALC FAMILY.

1. Talc.
  1. Foliated (common).
  2. Indurated.
  3. Earthy.
2. Serpentine.
  1. Precious.
  2. Common.
3. Steatite.
4. Potstone.

5. Nephrite.
  1. Common.
  2. Axestone.
6. Chlorite.
  1. Foliated.
  2. Common.
  3. Slaty.
  4. Earthy.
7. Asbestos.
  1. Flexible. (Amianth.)
  2. Common.
  3. Ligniform.
  4. Rock cork.
  5. Rock leather.

## CHRYSOLEITE FAMILY.

1. Chrysolite.
2. Olivine.

3d Genus.—(*Aluminous.*)

## RUBY FAMILY.

1. Corundum.
  1. Precious. (Sapphire.)
  2. Common.
  3. Splintery. }
  4. Granular. } (Emery.)
2. Chrysoberyl.
3. Spinel.
4. Ceylonite.
5. Automolite.

6. Andalusite.
7. Allophanite.

## NEPHELINE FAMILY

1. Nepheline.
2. Bucholzite.

## TOPAZ FAMILY.

1. Topaz.
2. Pyrophysalite.
3. Pycnite.

## CYANITE FAMILY.

1. Cyanite.
2. Rhætizite.
3. Blue-spar.
4. Fibrolite.
5. Grenatite.

4th Genus.—(*Zirconia.*)

## ZIRCON FAMILY.

1. Zircon.
  1. Zirconite.
  2. Hyacinth.
2. Eudyalite.

5th Genus.—(*Glucina.*)

1. Emerald.
2. Beryl.
3. Euclase.

## ORDER II.—ACIDIFEROUS EARTHY MINERALS.

1st Genus.—(*Calcareous.*)

## FAMILY OF CARBONATES.

1. Calcspar.
2. Slatespar.
3. Aphrite.
4. Rock milk.
5. Chalk.
6. Marble (foliated granular limestone).
7. Compact limestone.
8. Roestone.
9. Fibrous limestone (satin-spar.)
10. Peastone.
11. Calc-tuff.
12. Stalactite.
13. Lucullite.
  1. Crystalline.
  2. Compact.

3. Madreporite.
14. Hydrous carbonate of lime.
15. Arragonite.
16. Dolomite.
  1. Crystalline.
  2. Granular.
17. Magnesian limestone.
18. Gurhofite.
19. Pearl-spar, or brown-spar.
20. Marl.
  1. Earthy.
  2. Indurated.
  3. Bituminous marl-slate.

## FAMILY OF PHOSPHATES.

1. Apatite.
2. Phosphorite.

## FAMILY OF FLUATES.

1. Fluor.
  1. Foliated.
  2. Fibrous.
  3. Earthy.
  4. Compact.

## FAMILY OF SULPHATES.

1. Hydrous sulphate or gypsum.
  1. Foliated.
  2. Foliated-granular.
  3. Fibrous.
  4. Earthy.
2. Anhydrous sulphate or anhydrite.
  1. Foliated.
  2. Foliated-granular.
  3. Siliciferous.
3. Glauberite.
4. Polyhallite.

## FAMILY OF BORO-SILICATES.

1. Datholite.
2. Botryolite.

## FAMILY OF TUNGSTATES.

1. Tungstate of lime.

## FAMILY OF ARSENIATES.

1. Pharmacolite.

## FAMILY OF SILICATES.

1. Table-spar.

*2d Genus.—(Aluminous.)*

## FAMILY OF SULPHATES.

1. Alum.
2. Alumstone.
3. Aluminite.

## FAMILY OF PHOSPHATES.

1. Wavellite.
2. Azurite.

## FAMILY OF FLUATES.

1. Cryolite.

## FAMILY OF MELLATES.

1. Mellite.

*3d Genus.—(Magnesian.)*

## FAMILY OF CARBONATES.

1. Carbonate of magnesia.
2. Meerschaum.
3. Carbonate of magnesia and iron.

## FAMILY OF SULPHATES.

1. Epsom salt.

## FAMILY OF BORATES.

1. Boracite.

*4th Genus.—(Barytic.)*

## FAMILY OF CARBONATES.

1. Carbonate of barytes, or Witherite.
  1. Crystallized.
  2. Compact.
  3. Earthy.
2. Baryto-calcite.

## FAMILY OF SULPHATES.

1. Sulphate of barytes, or Heavy spar.
  1. Foliated.
  2. Columnar.
  3. Radiated, or Bolognian spar.
  4. Granular.
  5. Earthy.
  6. Compact.

5th Genus.—(*Strontian.*)

## FAMILY OF CARBONATES.

1. Strontianite.

## FAMILY OF SULPHATES.

1. Sulphate of strontian.
  1. Crystallized.
  2. Fibrous.

## ALKALINE CLASS.

1st Genus.—(*Salts of Potash.*)

## FAMILY OF NITRATES.

1. Nitrate of potash (salt-petre).

2d Genus.—(*Salts of Soda.*)

## FAMILY OF CARBONATES.

1. Carbonate of soda.
  1. Common.
  2. Fibrous. (*Trona.*)

## FAMILY OF SULPHATES.

1. Glauber salt.
2. Reussite.

## FAMILY OF MURIATES.

1. Rock salt.
2. Lake salt.

## FAMILY OF BORATES.

1. Borax.

3d Genus.—(*Salts of Ammonia.*)

## FAMILY OF SULPHATES.

1. Sulphate of ammonia.

## FAMILY OF MURIATES.

1. Sal ammoniac.

## METALLIC CLASS.

1st Genus.—(*Gold.*)

## FAMILY OF ALLOYS.

1. Native gold.
2. Brass-yellow native gold.
3. Electrum.

2d Genus.—(*Platinum.*)

1. Native platinum.

3d Genus.—(*Palladium.*)

1. Native paladium.

4th Genus.—(*Iridium.*)

1. Native iridium.

5th Genus.—(*Tellurium.*)

1. Native tellurium.
2. Graphic ore.
3. Yellow ore.
4. Black ore.

6th Genus.—(*Mercury.*)

## FAMILY OF ALLOYS.

1. Native mercury.
2. Amalgam.

## FAMILY OF SULPHURETS.

1. Cinnabar.
  1. Crystallized.

2. Pulverulent.
2. Hepatic ore.

## FAMILY OF CHLORIDE.

1. Horn quicksilver.

*7th Genus.—(Silver.)*

## FAMILY OF ALLOYS.

1. Native silver.
2. Auriferous silver.
3. Antimonial silver.
4. Arsenical silver.
5. Bismuthic silver.
6. Eukairite.

## FAMILY OF SULPHURETS.

1. Silver-glance.
2. Antimonial silver-glance.
3. Cupriferous silver-glance.
4. White silver-ore.
5. Red silver-ore.
  1. Dark red silver-ore.
  2. Light red silver-ore.

## FAMILY OF CHLORIDES.

1. Corneous silver-ore.

## FAMILY OF SALTS.

1. Carbonate of silver.

*8th Genus.—(Copper.)*

## FAMILY OF ALLOYS.

1. Native copper.

## FAMILY OF SULPHURETS.

1. Copper-glance.
  1. Compact.
  2. Foliated.
  3. Malleable.
2. Variegated copper-ore.
3. Copper pyrites.
4. Grey copper-ore.
5. Tennantite.
6. Black copper-ore.

## FAMILY OF OXYDES.

1. Red oxide.

1. Crystallized.

2. Ferruginous.(Tile-ore)

2. Black oxyde.

3. Hydrate.

1. Velvet copper-ore.

## FAMILY OF SALTS.

1. Carbonate.

1. Malachite.

1. Compact.

2. Fibrous.

2. Blue Carbonate.

2. Anhydrous carbonate.

3. Chrysocoll. (Subcarbonate.

4. Silicate. (Diopase.)

5. Carbosilicate.

6. Arseniate.

1. Lenticular.

2. Foliated. (Copper mica.)

3. Right rhombic.

4. Oblique rhombic.

5. Fibrous.

6. Ferruginous.

7. Skorodite.

7. Muriate.

8. Phosphate.

1. Anhydrous.

2. Hydrous.

9. Sulphate.

*9th Genus.—(Iron.)*

## FAMILY OF ALLOYS.

1. Native iron.

## FAMILY OF SULPHURETS.

1. Magnetic pyrites.

2. Common pyrites.

1. Crystallized.

2. Radiated.

## FAMILY OF OXYDES.

1. Magnetic iron-ore.

1. Crystallized.

2. Granular.



3. Arenaceous. (Iron-sand.)
2. Iron-glance.
  1. Common.
  2. Micaceous.
3. Red iron-ore.
  1. Red hæmatite.
  2. Compact red iron-ore.
  3. Red iron-froth.
  4. Red iron-ochre.
4. Hydrate of iron.
  1. Stilpnosiderite.
  2. Brown hæmatite.
  3. Compact brown iron-stone.
  4. Brown iron-froth.
  5. Ochry brown iron-stone.
  6. Globular hydrate.
    1. Lenticular.
    2. Kidney-form.
    3. Pisiform.
  7. Bog iron-ore.
    1. Morass-ore.
    2. Swamp-ore.
    3. Meadow-ore.
  8. Umber.

## FAMILY OF SALTS.

1. Carbonate.
  1. Crystallized.
  2. Fibrous.
  3. Clay ironstone.
    1. Common.
    2. Jaspery.
2. Phosphate.
  1. Crystallized.
  2. Earthy.
3. Arseniate.
4. Sulph-arseniate. (Pitchy iron-ore.)
5. Chromate.
6. Silicate.

1. Hedenbergite.
2. Yenite.
3. Pyrosmalite.
4. Knebelite.
7. Tungstate. (Wolfram.)
8. Sulphate.

10th Genus.—(*Manganese.*)

## FAMILY OF OXYDES.

1. Grey Oxyde.
  1. Foliated.
  2. Radiated.
  3. Fibrous.
  4. Compact.
  5. Earthy.
2. Black oxyde.
3. Wad.
4. Sulphuretted oxyde.

## FAMILY OF SALTS.

1. Phosphate.
2. Silicate.
  1. Compact.
  2. Foliated.
  3. Helvine.
3. Carbo-silicate.

11th Genus.—(*Uranium.*)

## FAMILY OF OXYDES.

1. Pitch-ore.
2. Uran-ochre.

## FAMILY OF SALTS.

1. Phosphate of Uranium.

12th Genus.—(*Cerium.*)

## FAMILY OF SALTS.

1. Silicate.
  1. Cerite.
  2. Allanite.
  3. Gadolinite.
  4. Orthite.

5. Pyrorthite.
2. Fluatē.
  1. Fluatē of cerium.
  2. Subfluatē.
  3. Yttroceritē.

13th Genus.—(*Tantalum*.)

FAMILY OF OXYDES.

1. Tantalite.
2. Yttrotantalite.

13th Genus.—(*Cobalt*.)

FAMILY OF ALLOYS.

1. White cobalt-ore. (Tin-white cobalt-ore.)
2. Cobalt-glance. (Silver-white cobalt-ore.)
3. Grey cobalt-ore.

FAMILY OF SULPHURETS.

1. Cobalt pyrites.

FAMILY OF OXYDES.

1. Black cobalt-ochre.
2. Brown cobalt-ochre.
3. Yellow cobalt-ochre.

FAMILY OF SALTS.

1. Arseniate.
2. Sulphate.

13th Genus.—(*Nickel*.)

FAMILY OF ALLOYS.

1. Native nickel.
2. Copper-nickel.
3. Glance-nickel.

FAMILY OF OXYDES.

1. Nickel ochre.

FAMILY OF SALTS.

1. Arseniate of nickel.

14th Genus.—(*Molybdenum*.)

FAMILY OF SULPHURETS.

1. Common sulphuret.

FAMILY OF OXYDES.

1. Molybdenum ochre.

15th Genus.—(*Tin*.)

FAMILY OF SULPHURETS.

1. Bell-metal ore, or tin pyrites.

FAMILY OF OXYDES.

1. Tinstone.
  1. Crystallized.
  2. Granular.
  3. Fibrous, or wood-tin.

16th Genus.—(*Titanium*.)

FAMILY OF OXYDES.

1. Rutile.
2. Anatase.
3. Menaccanite.
4. Iserine.
5. Nigrine.

FAMILY OF SALTS.

1. Sphène.

17th Genus.—(*Zinc*.)

FAMILY OF SULPHURETS.

1. Blende.
  1. Yellow.
  2. Brown.
  3. Black.
  4. Fibrous.

FAMILY OF OXYDES.

1. Red oxyde of zinc.

FAMILY OF SALTS.

1. Silicate. (Electric calamine.)
2. Carbonate.
  1. Crystallized.
  2. Earthy.

18th Genus.—(*Bismuth*.)

FAMILY OF ALLOYS.

1. Native Bismuth.

## FAMILY OF SULPHURETS.

1. Bismuth-glance.
2. Cupriferous bismuth-glance.
3. Plumbo-cupriferous, or needle-ore.

## FAMILY OF OXYDES.

1. Bismuth ochre.

19th Genus.—(*Lead.*)

## FAMILY OF ALLOYS.

1. Native lead.

## FAMILY OF SULPHURETS.

1. Galena.
  1. Foliated.
  2. Steel-grained.
2. Blue lead-ore.
3. Antimonial sulphuret.
4. Bournonite.
5. Arsenio-sulphuret.

## FAMILY OF OXYDES.

1. Yellow oxyde.
2. Red oxyde.

## FAMILY OF SALTS.

1. Carbonate of lead.
  1. Crystallized.
  2. Earthy.
2. Murio-carbonate.
3. Phosphate of lead.
  1. Green.
  2. Brown.
4. Arsenio-phosphate.
5. Chromate.

6. Sulphate.
7. Molybdate.
8. Arseniate.
9. Antimonial-arseniate.
10. Tungstate.
11. Aluminate.

20th Genus.—(*Antimony.*)

## FAMILY OF ALLOYS.

1. Native antimony.

## FAMILY OF SULPHURETS.

1. Grey antimony-ore.
  1. Compact.
  2. Radiated.
  3. Fibrous.
  4. Plumose.
2. Nickeliferous grey antimony-ore.

## FAMILY OF OXYDES.

1. White oxyde.
2. Red oxyde.
3. Antimony-ochre.

21st Genus.—(*Arsenic.*)

## FAMILY OF ALLOYS.

1. Native arsenic.

## FAMILY OF SULPHURETS.

1. Orpiment.
  1. Realgar.
  2. Yellow orpiment.

## FAMILY OF OXYDES.

1. Native oxyde.

## INFLAMMABLE CLASS.

1st Genus.—(*Carbonaceous.*)

## DIAMOND FAMILY.

1. Diamond.

## GRAPHITE FAMILY.

1. Mineral charcoal.
2. Graphite.
3. Glance-coal.

2d Genus.—(*Bituminous.*)

## BITUMEN FAMILY.

1. Naphtha.
2. Petroleum.
3. Mineral pitch.
  1. Asphaltum.
  2. Elastic mineral pitch.
  3. Earthy mineral pitch.

## COAL FAMILY.

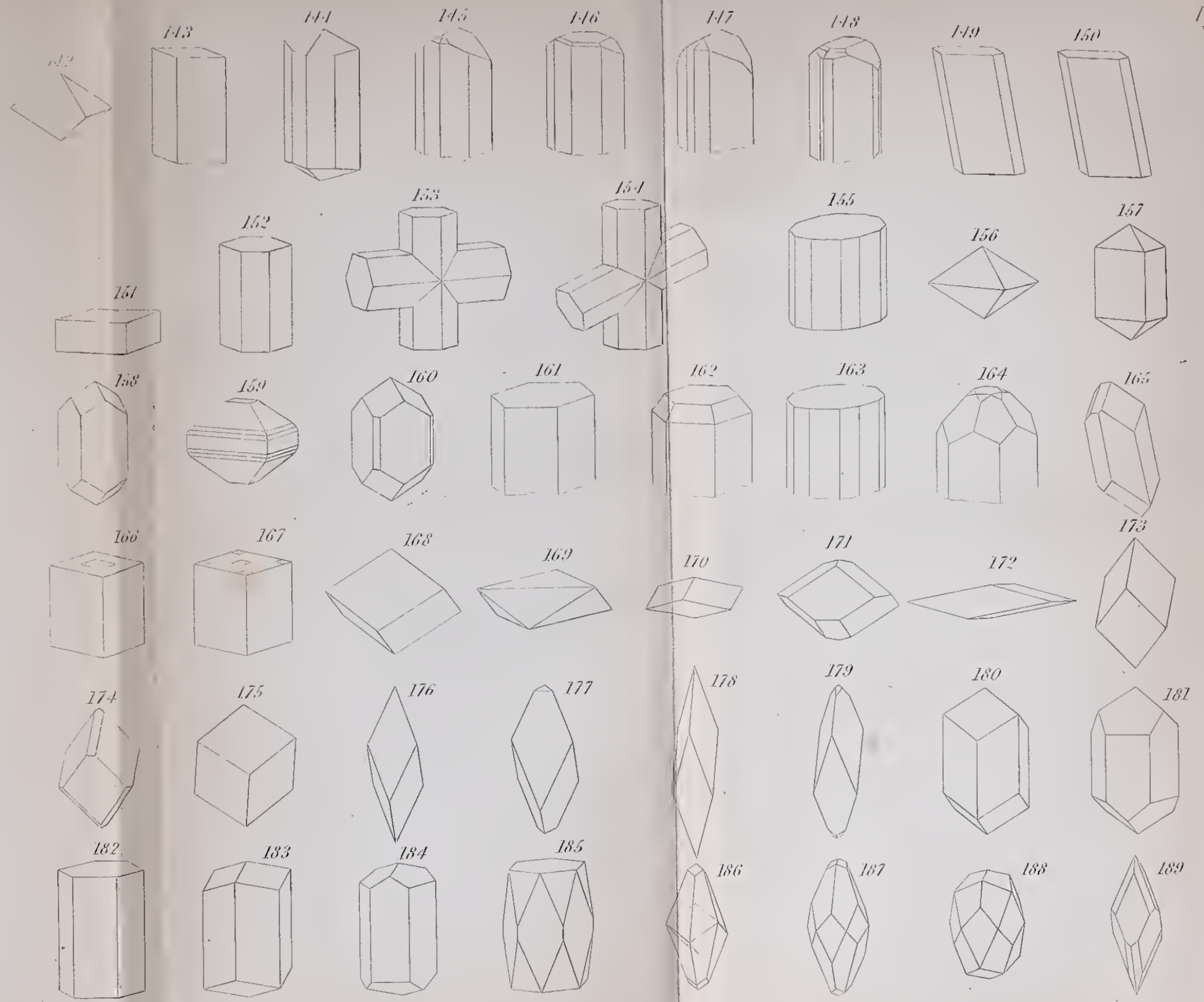
1. Black coal.
  1. Jet.
  2. Cannel coal.
  3. Slate coal.
  4. Soot coal.
  5. Coarse coal.
2. Brown coal.
  1. Bituminous wood.
  2. Moor coal.

*3d Genus.—(Resins.)*

1. Amber.
2. Fossil-copal.
3. Retin-asphalt.

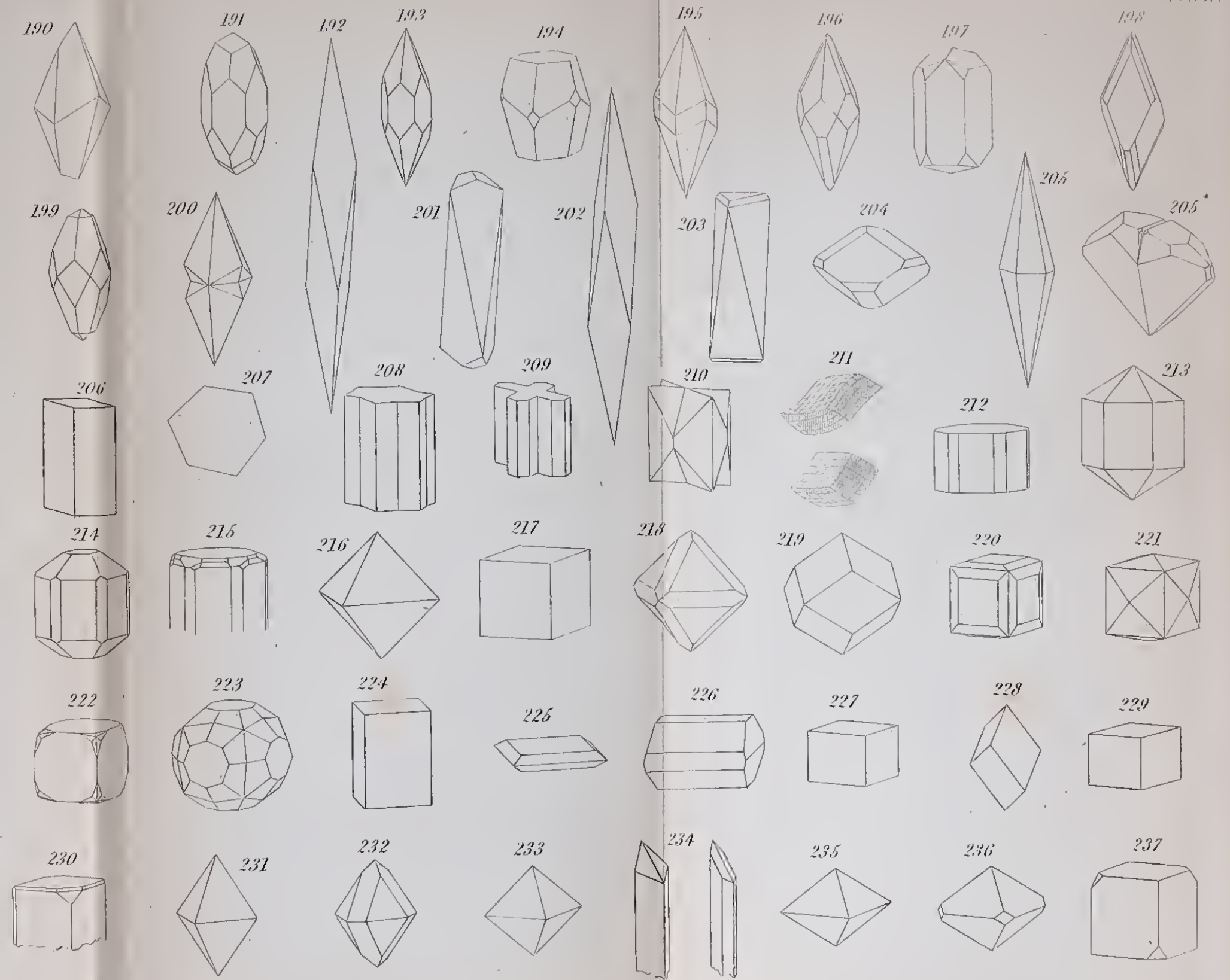
*4th Genus.—(Sulphur.)*

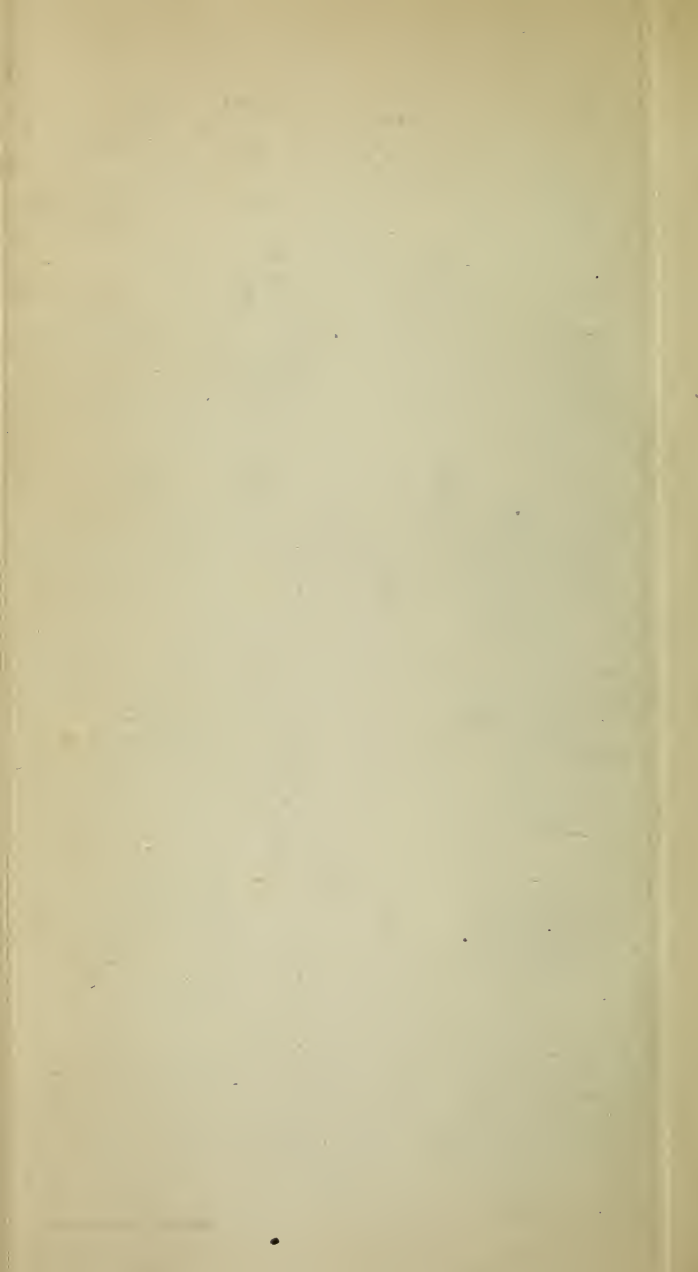
1. Native sulphur.
  1. Crystallized.
  2. Volcanic.

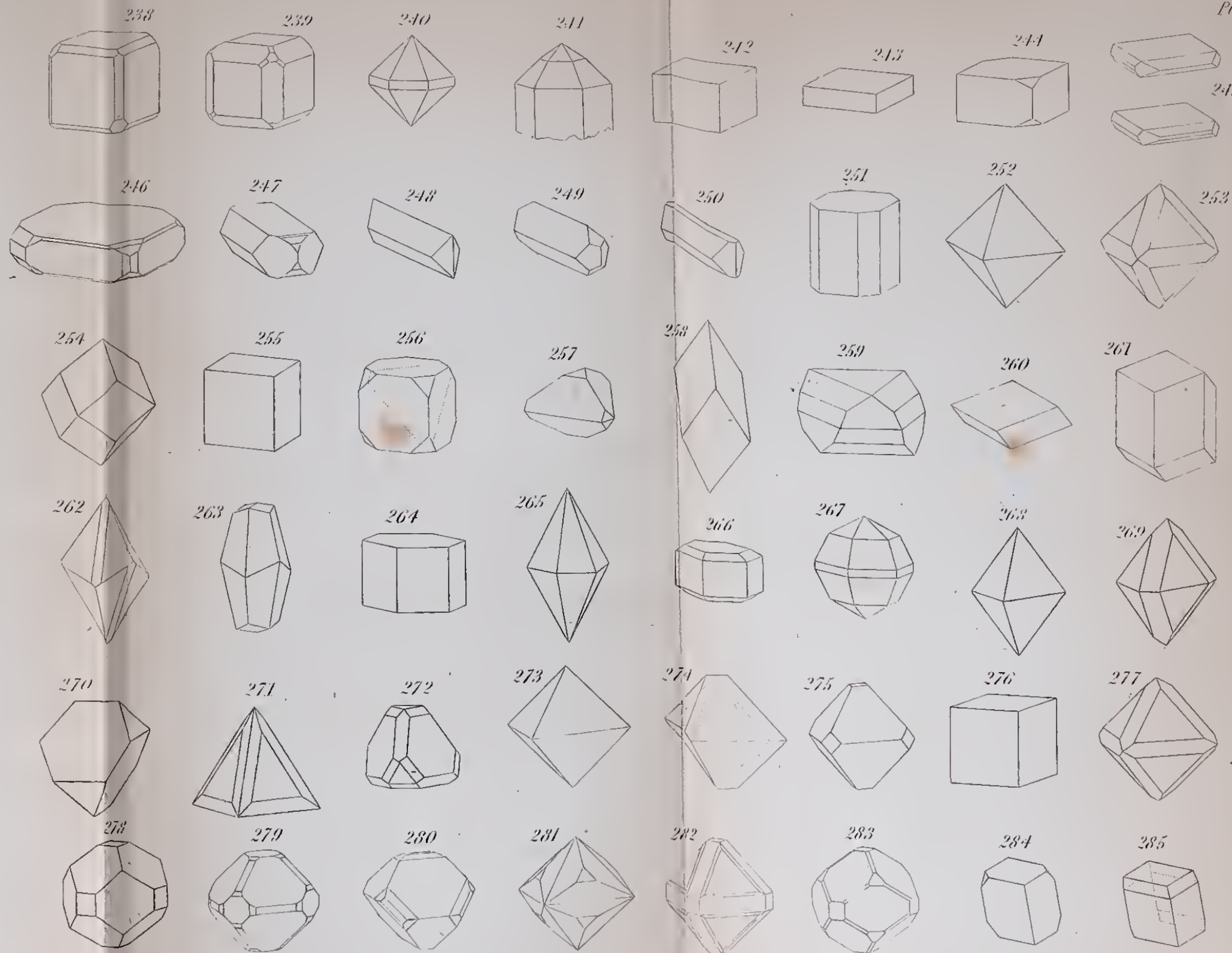




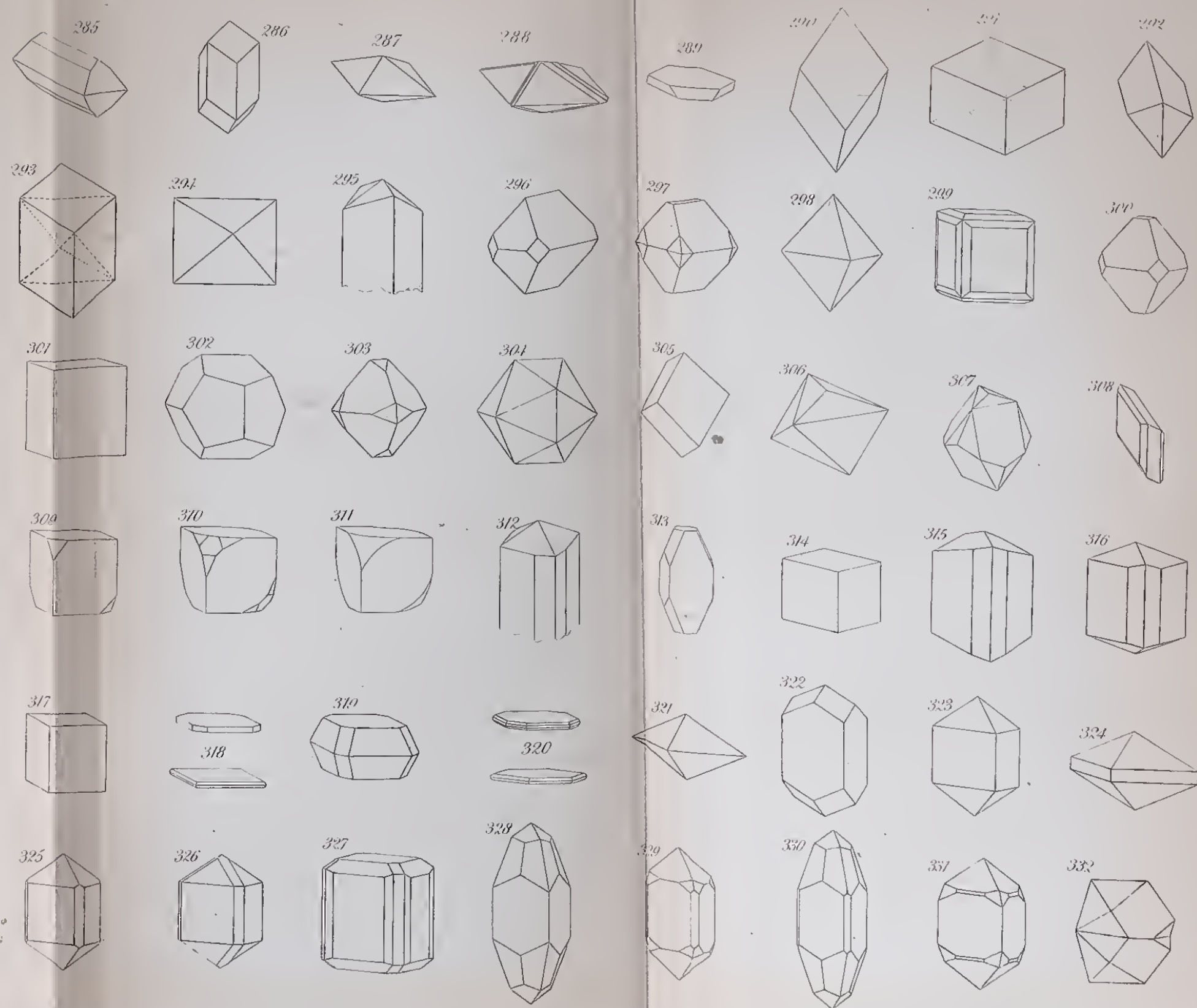












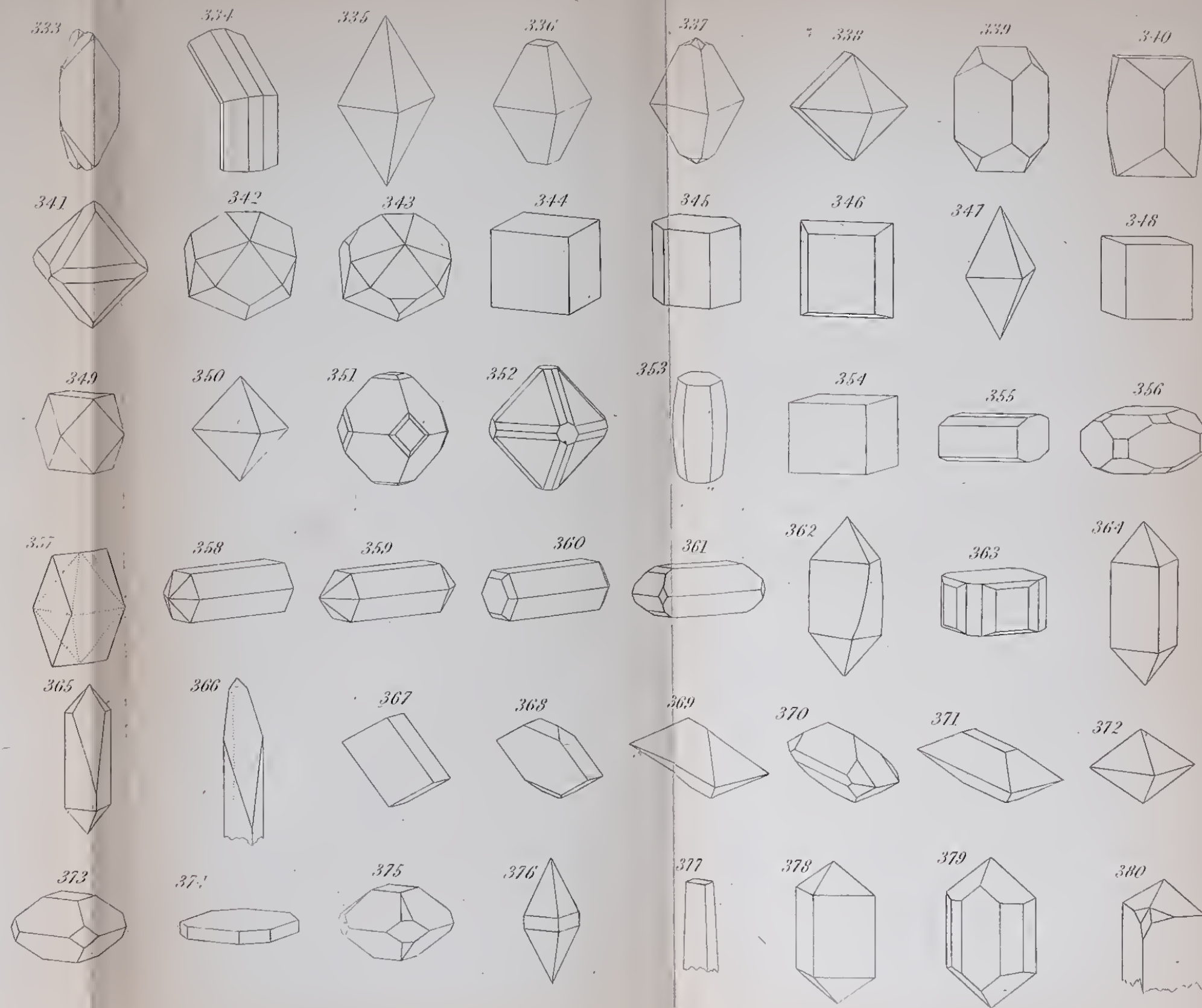
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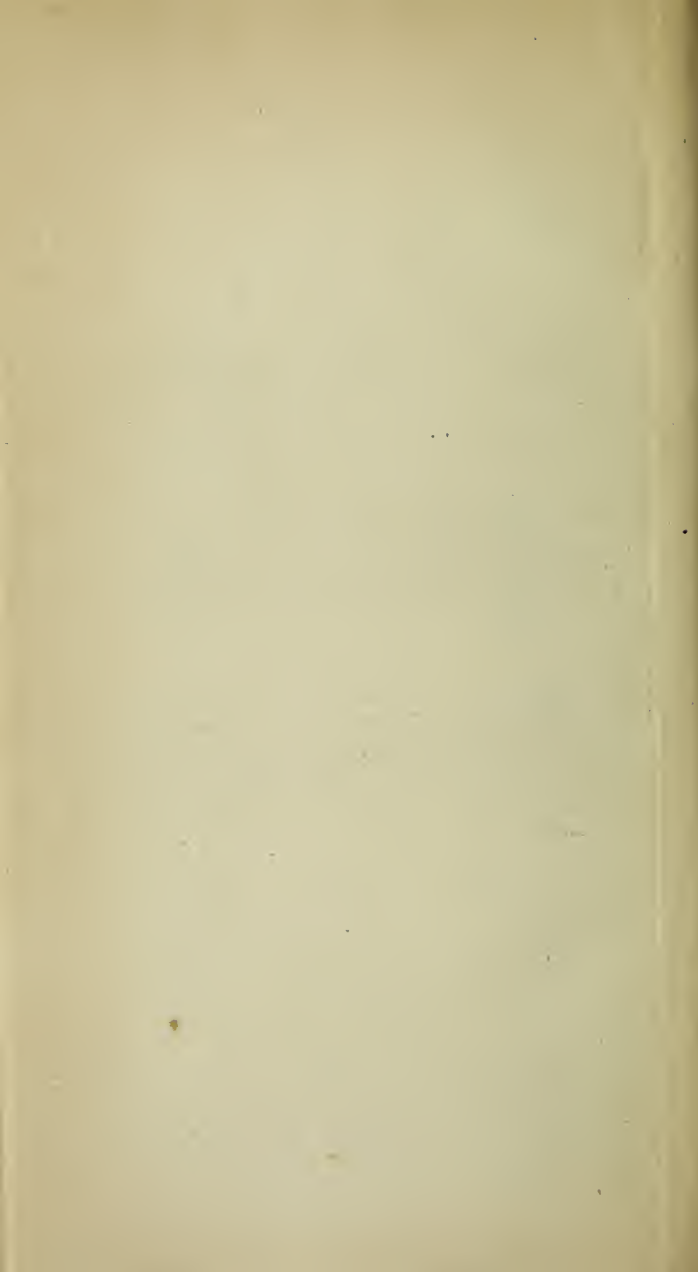
*London. Published by Longman, Hurst, Rees, Orme, & Brown, 1822.*

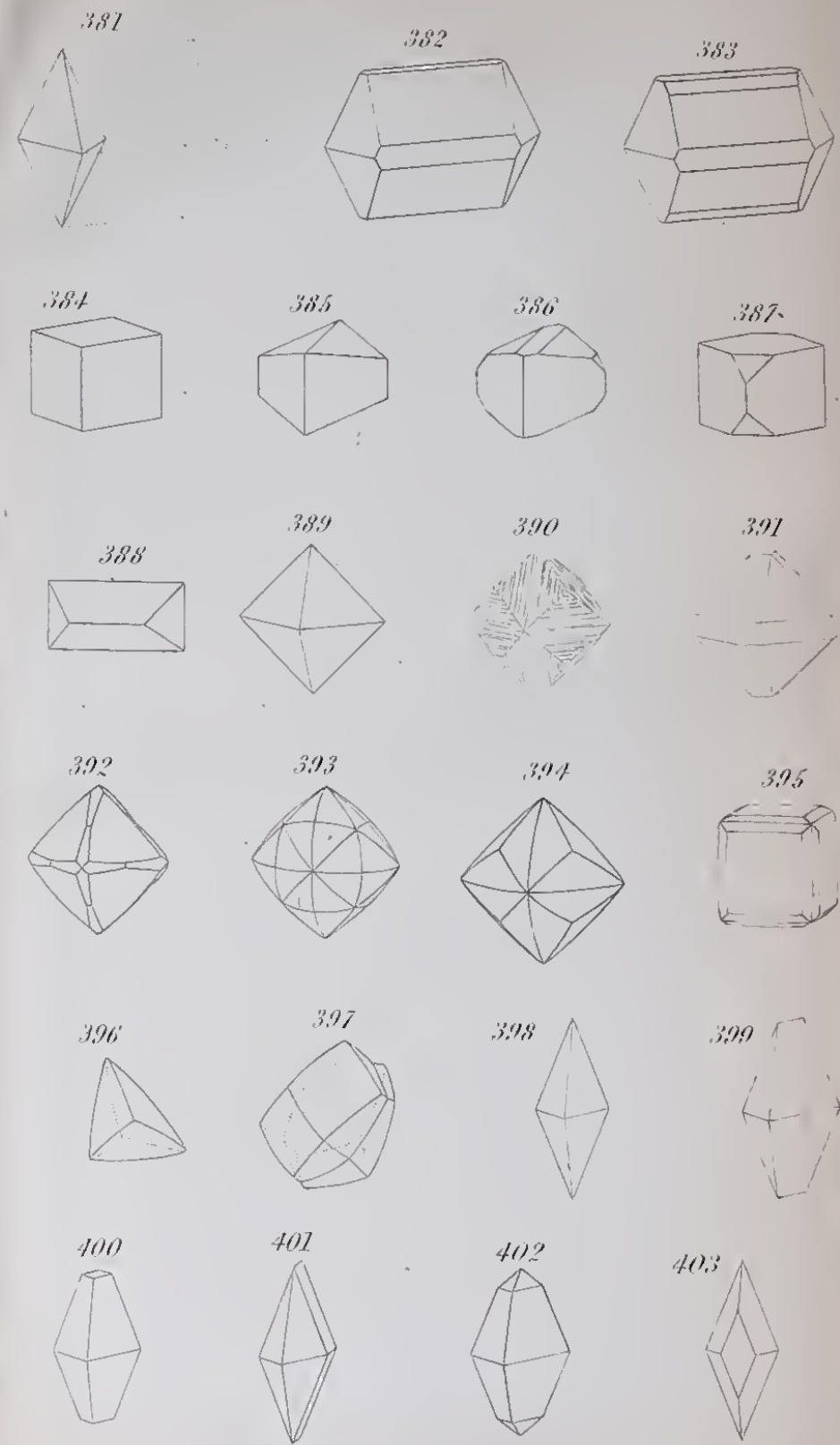
*Engraved by W. & Miss L. Lowry.*











Drawn by Miss Lowry.

Engr'd by W. & Miss Lowry.



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